COHERENT Experiment and Implications

Artwork by Sandbox Studio, Chicago with Ana Kova

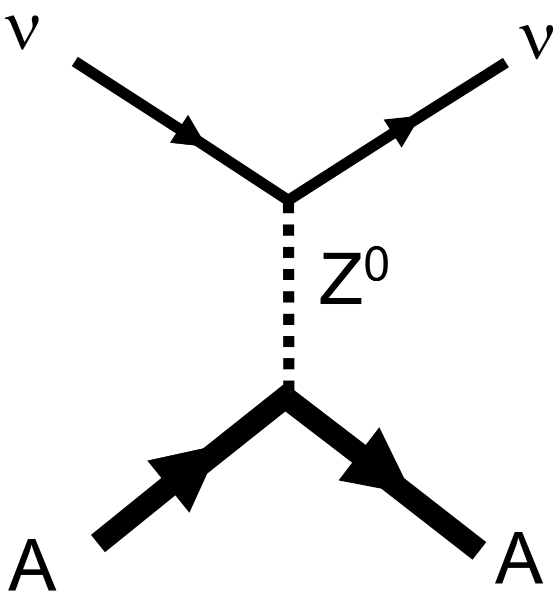
Kate Scholberg, Duke University
PHENO 2019, Pittsburgh,
March 20, 2019

OUTLINE

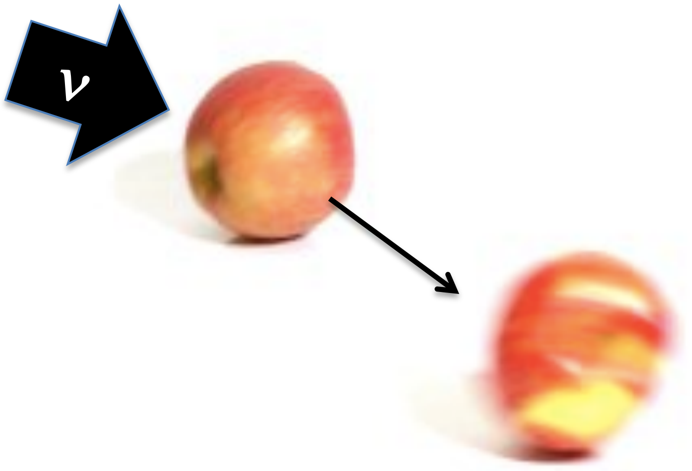
- Coherent elastic neutrino-nucleus scattering (CEvNS)
- Physics motivations
- The COHERENT experiment at the SNS
- COHERENT results
  - CsI[Na] measurement and interpretation
- Future prospects for COHERENT

Coherent elastic neutrino-nucleus scattering (CEvNS)

$\nu + A \rightarrow \nu + A$



A neutrino smacks a nucleus via exchange of a Z, and the nucleus recoils as a whole; **coherent** up to E_ν~ 50 MeV



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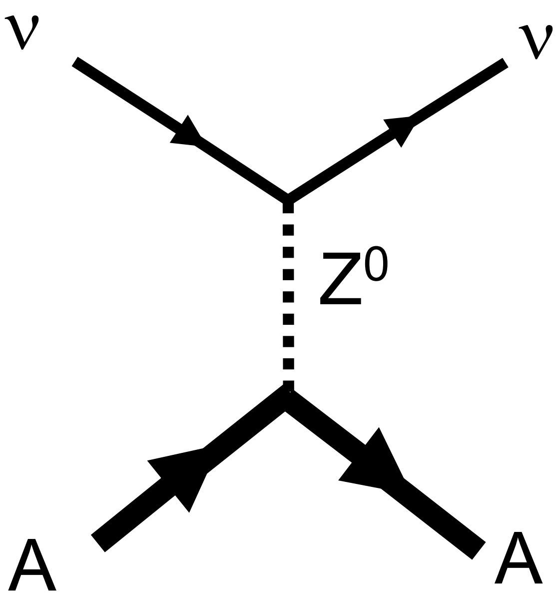

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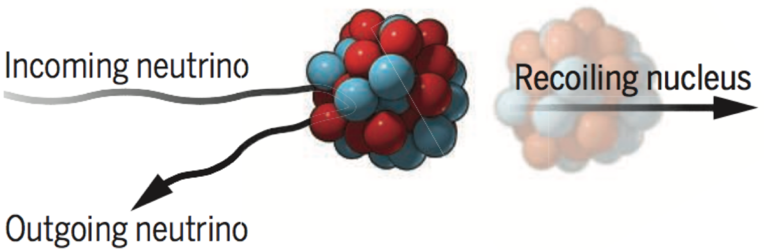


Nucleon wavefunctions
in the target nucleus
are **in phase with each other**
at low momentum transfer

For $QR << 1$, [total xscn] ~ A^2 * [single constituent xscn]

A: no. of constituents

Image: J. Link *Science* Perspectives

`\begin{aside}`

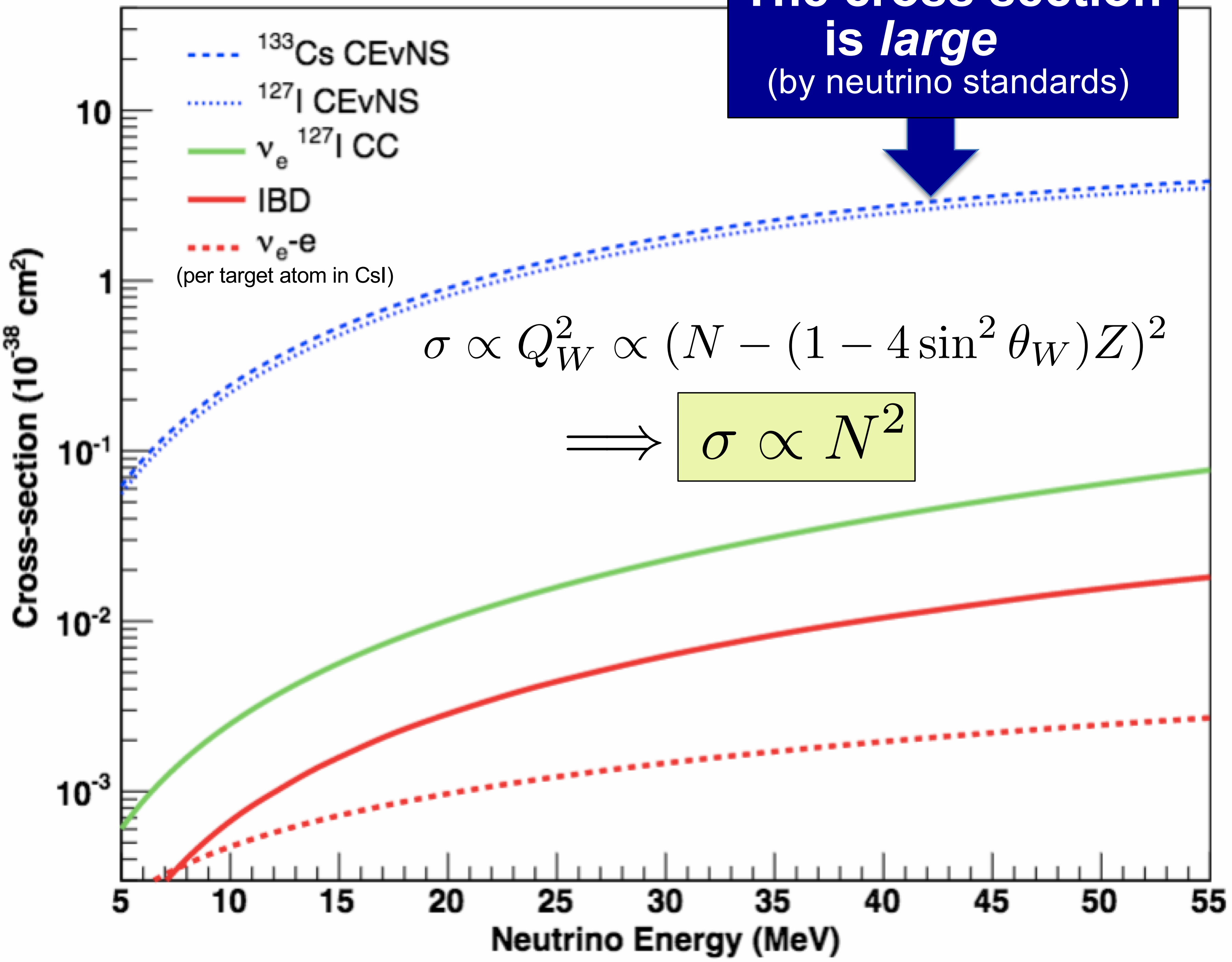
Literature has CNS, CNNS, CENNS, ...

- I prefer including “E” for “elastic”... otherwise it gets frequently confused with coherent pion production at ~GeV neutrino energies
- I’m told “NN” means “nucleon-nucleon” to nuclear types
- CEνNS is a possibility but those internal Greek letters are annoying

➔**CEvNS**, pronounced “sevens”...

spread the meme!

`\end{aside}`



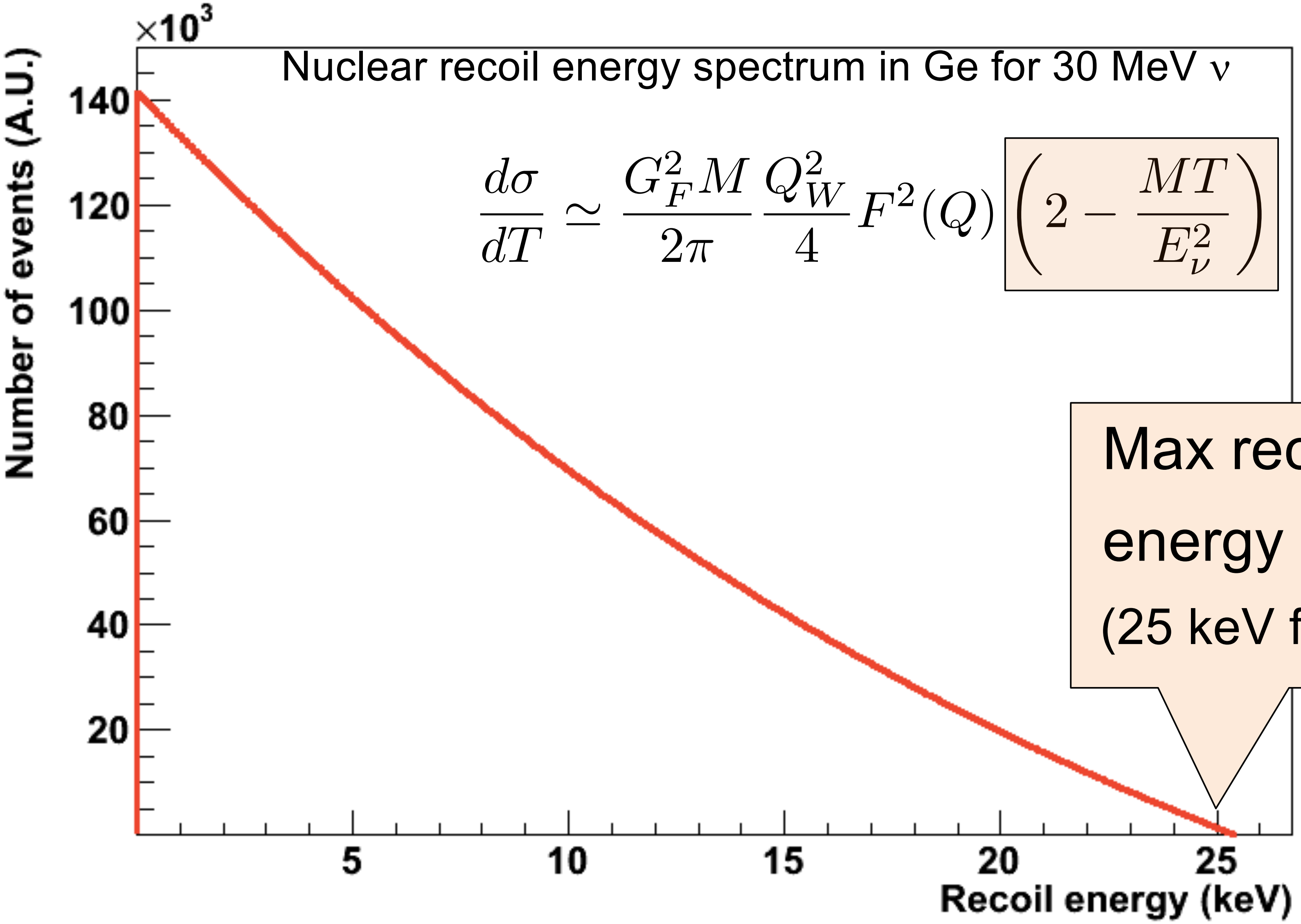
The cross section is *large*

(by neutrino standards)

$$\sigma \propto Q_W^2 \propto (N - (1 - 4\sin^2\theta_W)Z)^2$$

$$\Longrightarrow \boxed{\sigma \propto N^2}$$

Large cross section (by neutrino standards) but hard to observe due to **tiny nuclear recoil energies:**



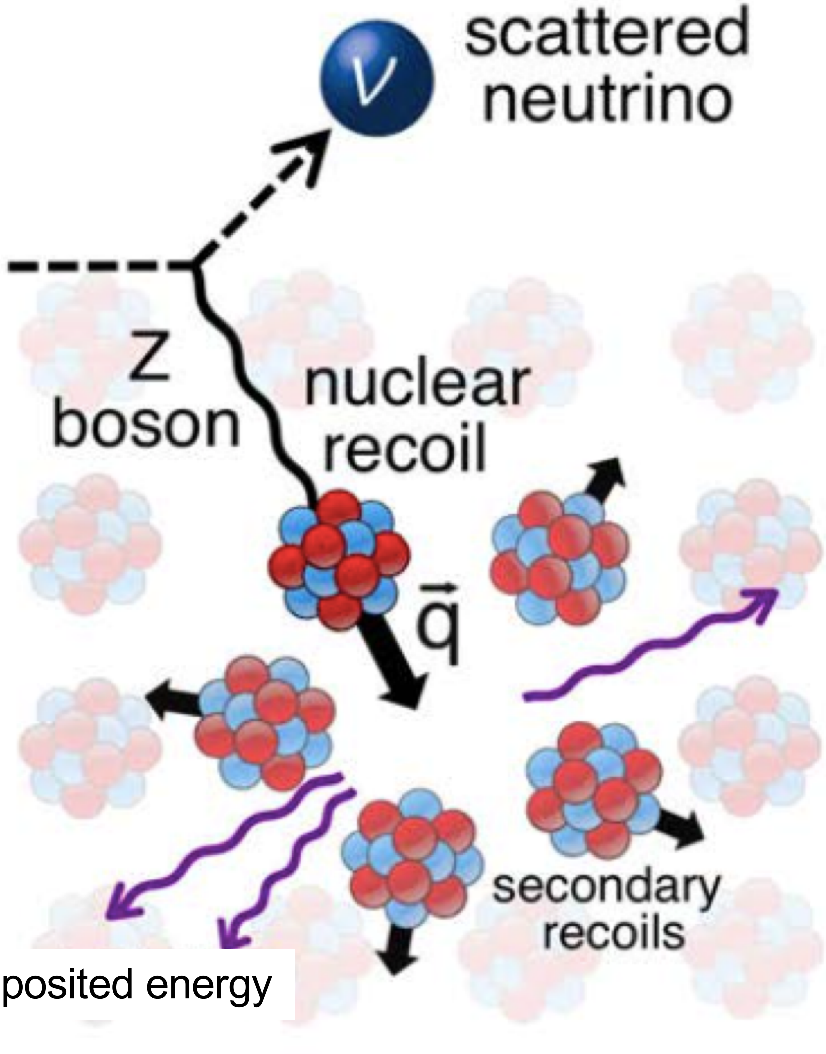
$$\frac{d\sigma}{dT} \simeq \frac{G_F^2 M}{2\pi} \frac{Q_W^2}{4} F^2(Q) \boxed{\left(2 - \frac{MT}{E_\nu^2}\right)}$$

Max recoil energy is ~$2E_\nu^2/M$

(25 keV for Ge)

The only experimental signature:

tiny energy deposited by nuclear recoils in the target material



➔ **WIMP dark matter detectors** developed over the last ~decade are sensitive to ~ keV to 10’s of keV recoils

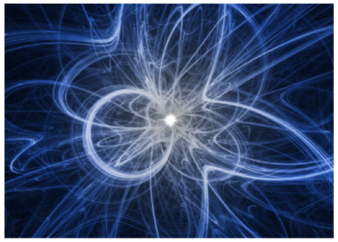
CEvNS: what's it good for?

① So
② Many
③ Things

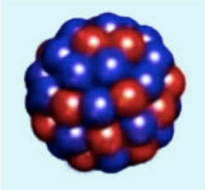
!

(not a
complete list!)

CEvNS as a **signal**
for signatures of *new physics*



CEvNS as a **signal**
for understanding of "old" physics



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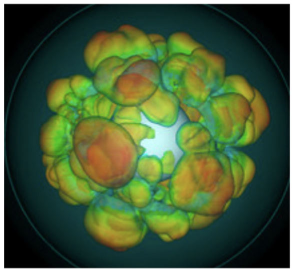
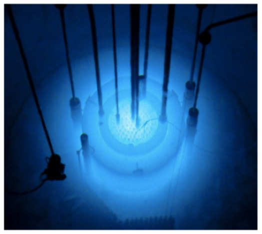
for signatures of new physics

CEvNS as a **signal** for *astrophysics*



CEvNS as a **practical tool**



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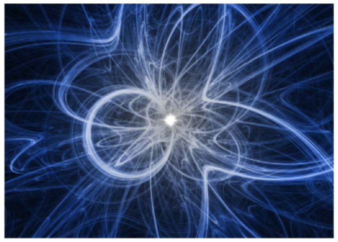

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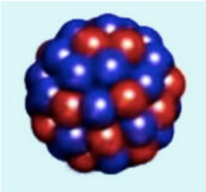

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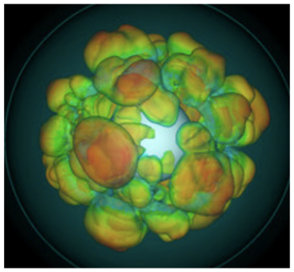

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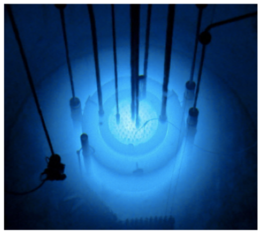

The cross section is cleanly predicted in the Standard Model

$$\frac{d\sigma}{dT} = \frac{G_F^2 M}{\pi} F^2(Q) \left[(G_V + G_A)^2 + (G_V - G_A)^2 \left(1 - \frac{T}{E_\nu}\right)^2 - (G_V^2 - G_A^2) \frac{MT}{E_\nu^2} \right]$$

E_ν: neutrino energy

T: nuclear recoil energy

M: nuclear mass

Q = √ (2 M T): momentum transfer

G_V, G_A: SM weak parameters

vector $G_V = g_V^p Z + g_V^n N,$ ← dominates

axial $G_A = g_A^p (Z_+ - Z_-) + g_A^n (N_+ - N_-)$ ← small for most nuclei, zero for spin-zero

$$\begin{aligned} g_V^p &= 0.0298 \\ g_V^n &= -0.5117 \\ g_A^p &= 0.4955 \\ g_A^n &= -0.5121. \end{aligned}$$

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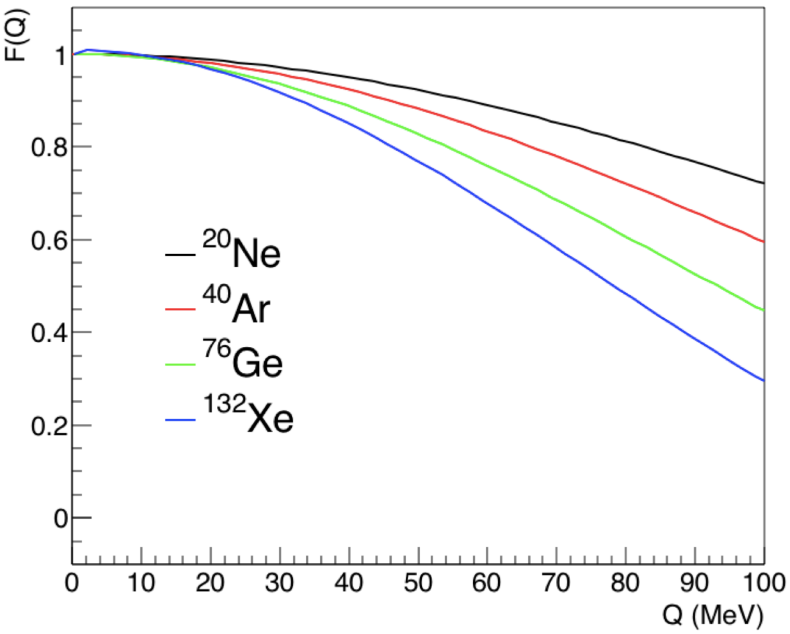
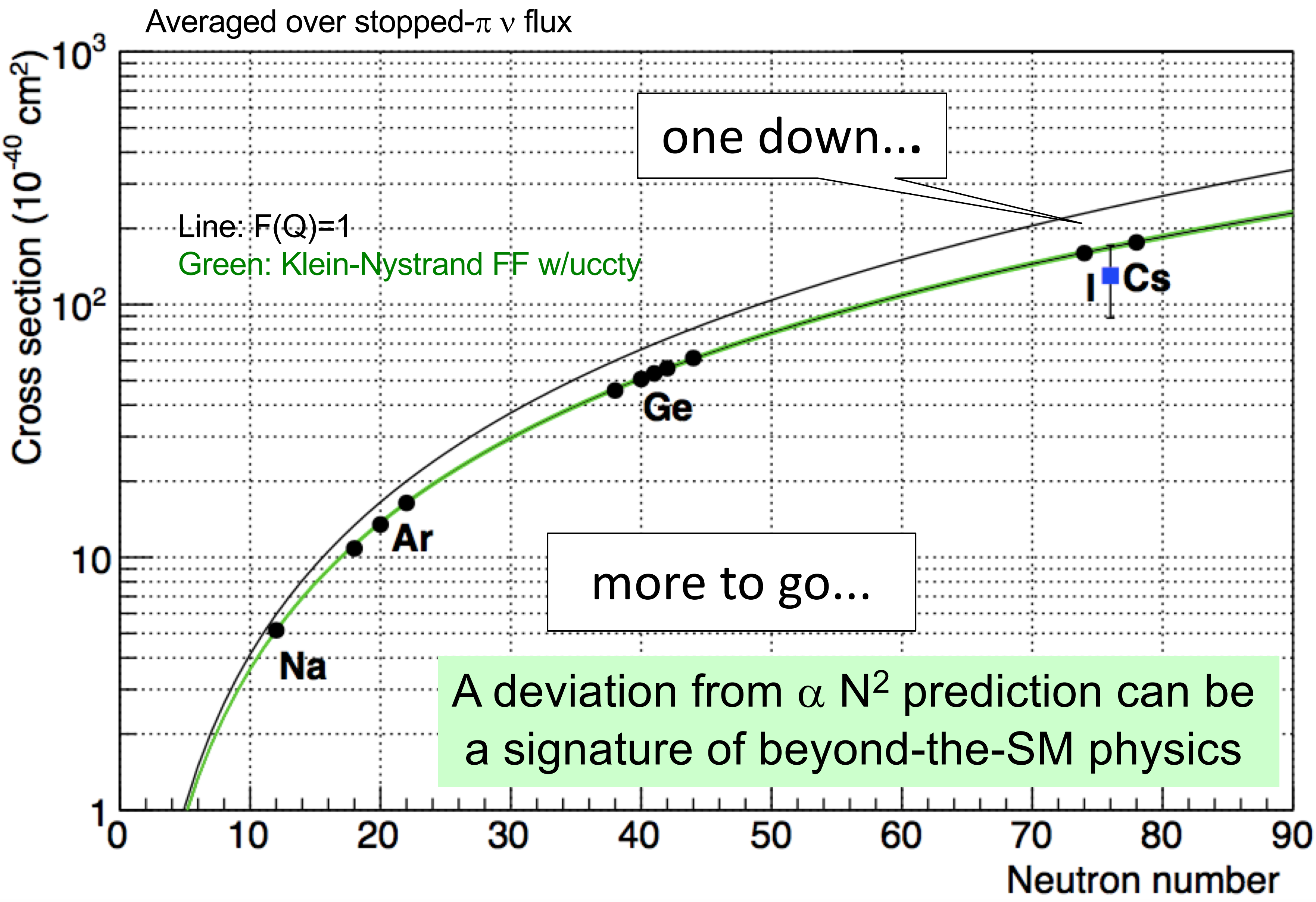
E_ν: neutrino energy
T: nuclear recoil energy
M: nuclear mass
Q = √ (2 M T): momentum transfer

F(Q): nuclear **form factor**, <~5% uncertainty on event rate



form factor suppresses cross section at large Q

Need to measure **N^2 dependence** of the CEvNS xscn



one down...

more to go...

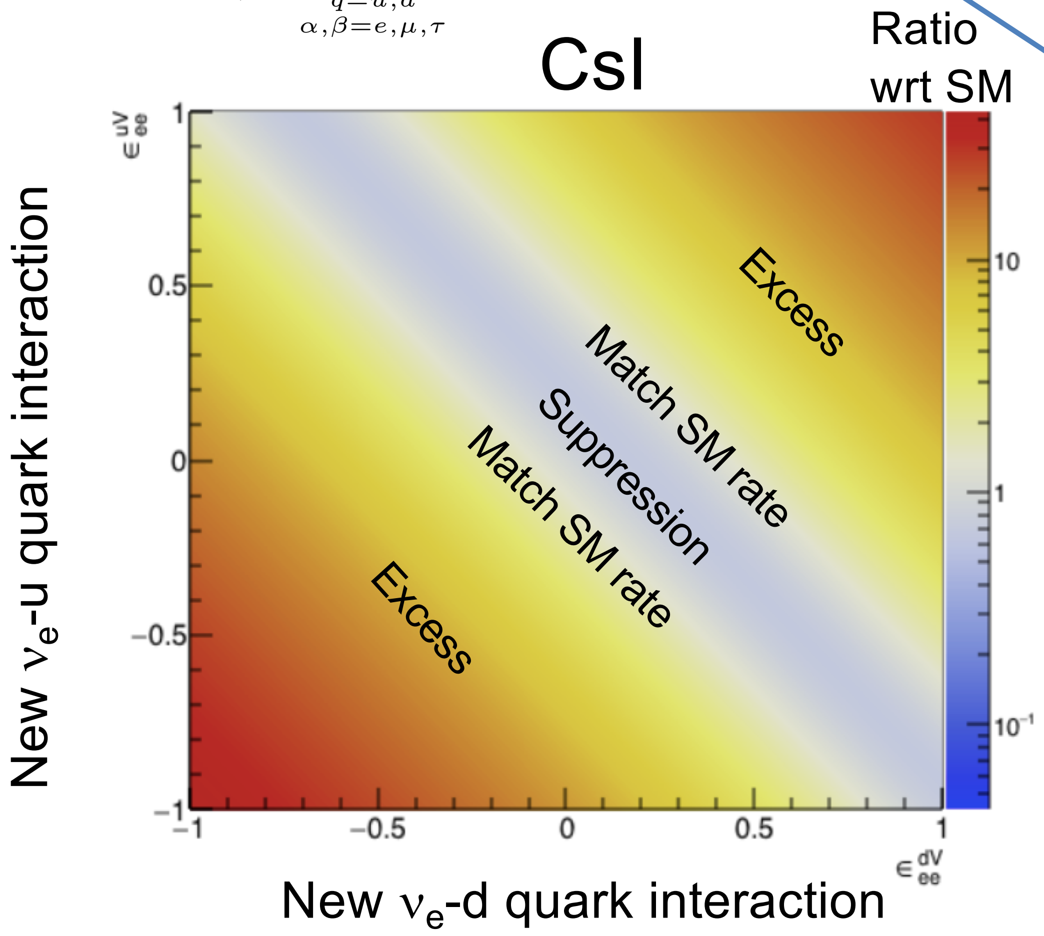
A deviation from α N^2 prediction can be a signature of beyond-the-SM physics

Non-Standard Interactions of Neutrinos:

new interaction **specific to ν's**

Look for a CEvNS **excess** or **deficit** wrt SM expectation

$$\mathcal{L}_{\nu H}^{NSI} = -\frac{G_F}{\sqrt{2}} \sum_{\substack{q=u,d\\ \alpha,\beta=e,\mu,\tau}} [\bar{\nu}_\alpha \gamma^\mu (1-\gamma^5)\nu_\beta] \times (\varepsilon_{\alpha\beta}^{qL}[\bar{q}\gamma_\mu(1-\gamma^5)q] + \varepsilon_{\alpha\beta}^{qR}[\bar{q}\gamma_\mu(1+\gamma^5)q])$$



If these ε's are ~unity, there is a new interaction of ~Standard-model size... many not currently well constrained

For heavy mediators, expect ***overall scaling*** of CEvNS event rate, depending on N, Z

Example models: Barranco et al. JHEP 0512 & references therein: extra neutral gauge bosons, leptoquarks, R-parity-breaking interactions

More studies: see https://sites.duke.edu/nueclipse/files/2017/04/Dent-James-NuEclipse-August-2017.pdf

Other new physics results in a *distortion of the recoil spectrum* (Q dependence)

BSM Light Mediators

SM weak charge

Effective weak charge in presence of light vector mediator Z'

$$Q^2_{\alpha,\mathrm{SM}} = \left(Z g_p^V + N g_n^V\right)^2$$

$$Q^2_{\alpha,\mathrm{NSI}} = \left[Z\left(g_p^V + \frac{3g^2}{2\sqrt{2}G_F(Q^2+M^2_{Z'})}\right) + N\left(g_n^V + \frac{3g^2}{2\sqrt{2}G_F(Q^2+M^2_{Z'})}\right)\right]^2$$

specific to neutrinos and quarks

e.g. arXiv:1708.04255

Neutrino (Anomalous) Magnetic Moment

e.g. arXiv:1505.03202, 1711.09773

$$\left(\frac{d\sigma}{dT}\right)_m = \frac{\pi\alpha^2\mu_\nu^2 Z^2}{m_e^2}\left(\frac{1-T/E_\nu}{T} + \frac{T}{4E_\nu^2}\right)$$

Specific ~1/T upturn at low recoil energy

Sterile Neutrino Oscillations

$$P^{\mathrm{SBL}}_{\nu_\alpha\to\nu_\alpha}(E_\nu) = 1 - \sin^2 2\theta_{\alpha\alpha}\sin^2\left(\frac{\Delta m^2_{41}L}{4E_\nu}\right)$$

"True" disappearance with baseline-dependent Q distortion

e.g. arXiv: 1511.02834, 1711.09773, 1901.08094

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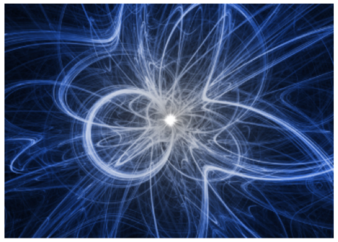

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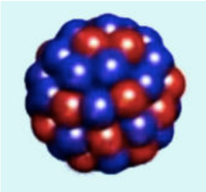

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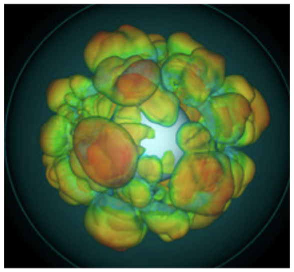

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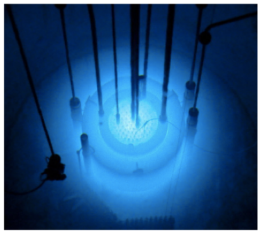
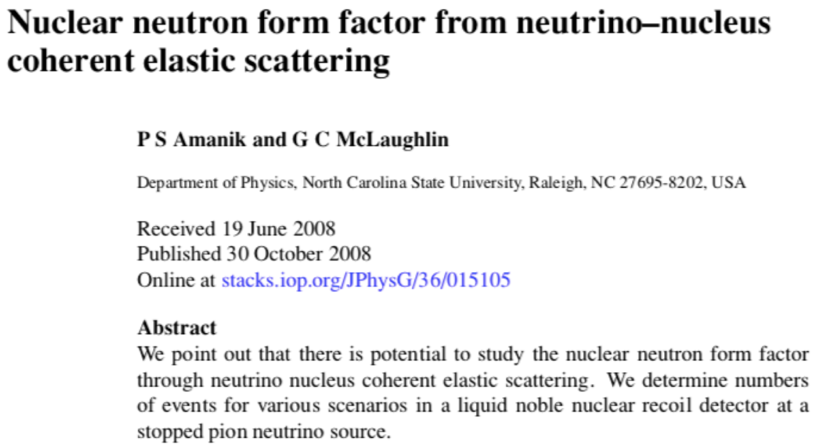


What can we learn about **nuclear physics** with CEvNS**?**



Nuclear neutron form factor from neutrino–nucleus coherent elastic scattering

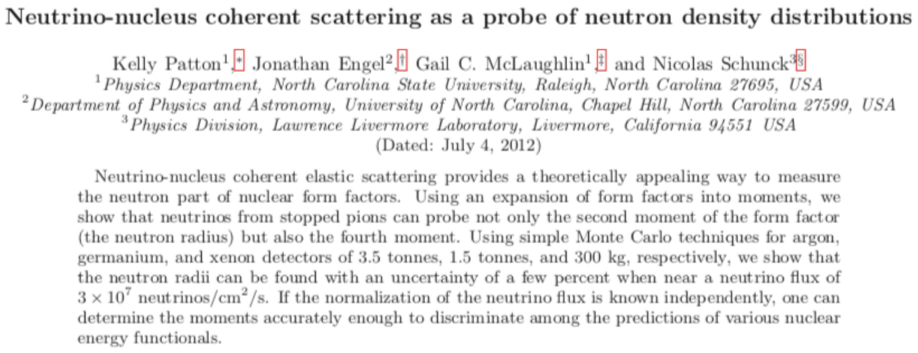
P S Amanik and G C McLaughlin

Department of Physics, North Carolina State University, Raleigh, NC 27695-8202, USA

Received 19 June 2008
Published 30 October 2008
Online at stacks.iop.org/JPhysG/36/015105

Abstract

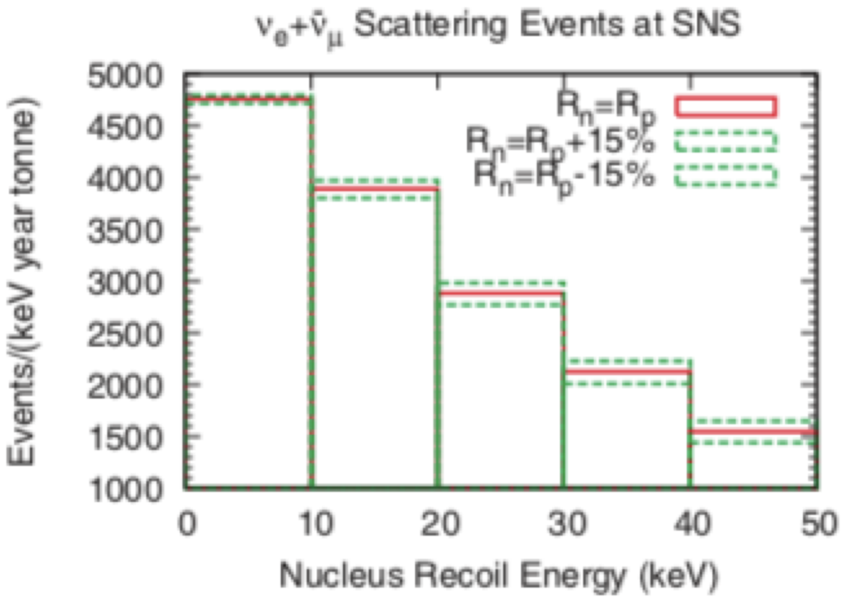
We point out that there is potential to study the nuclear neutron form factor through neutrino nucleus coherent elastic scattering. We determine numbers of events for various scenarios in a liquid noble nuclear recoil detector at a stopped pion neutrino source.



Neutrino-nucleus coherent scattering as a probe of neutron density distributions

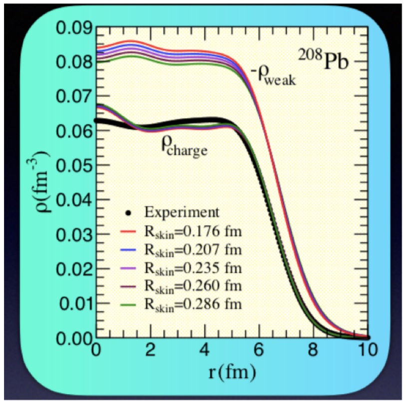
Kelly Patton[1,*] Jonathan Engel[2,†] Gail C. McLaughlin[1,‡] and Nicolas Schunck[3§]
[1] Physics Department, North Carolina State University, Raleigh, North Carolina 27695, USA
[2] Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27599, USA
[3] Physics Division, Lawrence Livermore Laboratory, Livermore, California 94551 USA
(Dated: July 4, 2012)

Neutrino-nucleus coherent elastic scattering provides a theoretically appealing way to measure the neutron part of nuclear form factors. Using an expansion of form factors into moments, we show that neutrinos from stopped pions can probe not only the second moment of the form factor (the neutron radius) but also the fourth moment. Using simple Monte Carlo techniques for argon, germanium, and xenon detectors of 3.5 tonnes, 1.5 tonnes, and 300 kg, respectively, we show that the neutron radii can be found with an uncertainty of a few percent when near a neutrino flux of 3×10^7 neutrinos/cm^2/s. If the normalization of the neutrino flux is known independently, one can determine the moments accurately enough to discriminate among the predictions of various nuclear energy functionals.



Observable is **recoil spectrum shape**

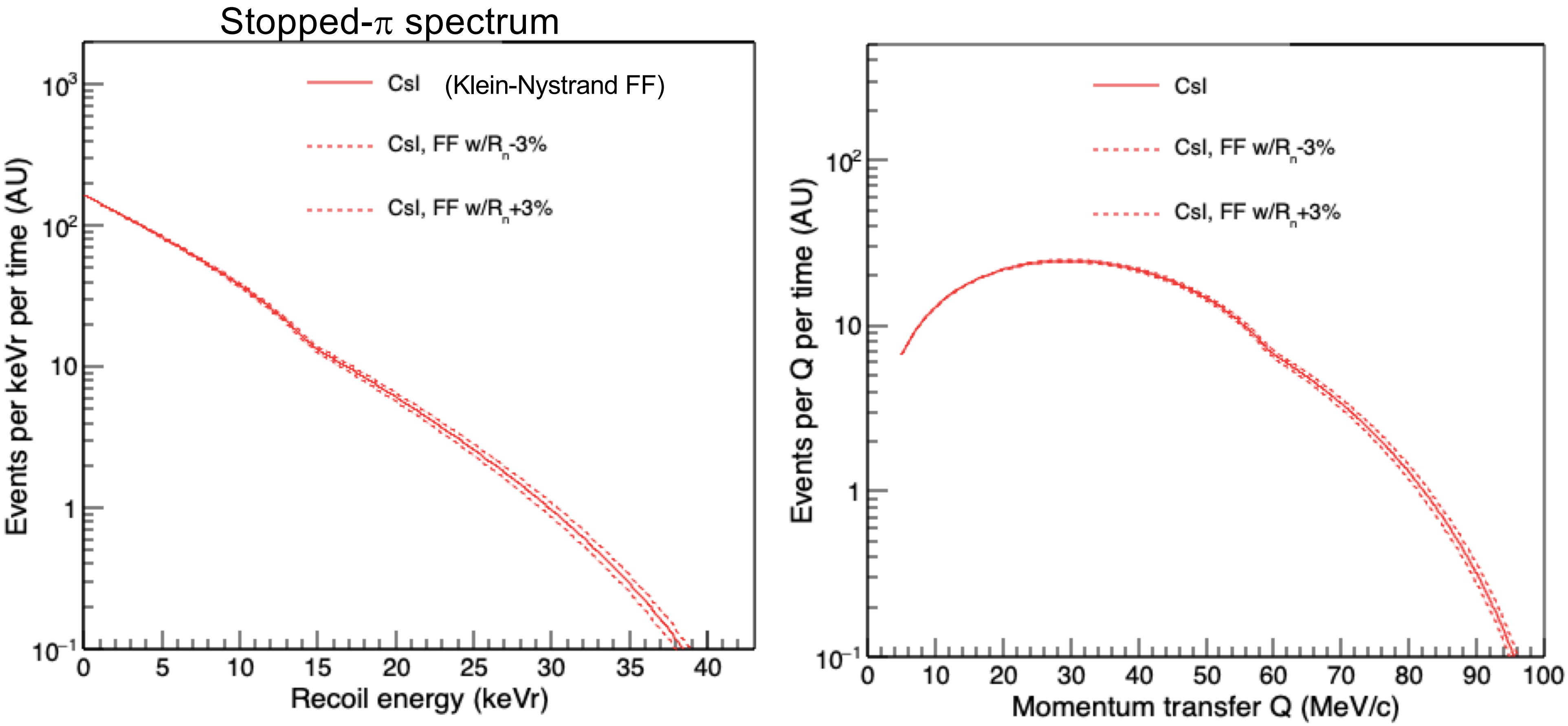
Neutron radius and “skin” (R_n-R_p) relevant for understanding of neutron stars



J. Piekarewicz

Effect of form-factor *uncertainty* on the recoil spectrum: estimate as R_n +/- 3%

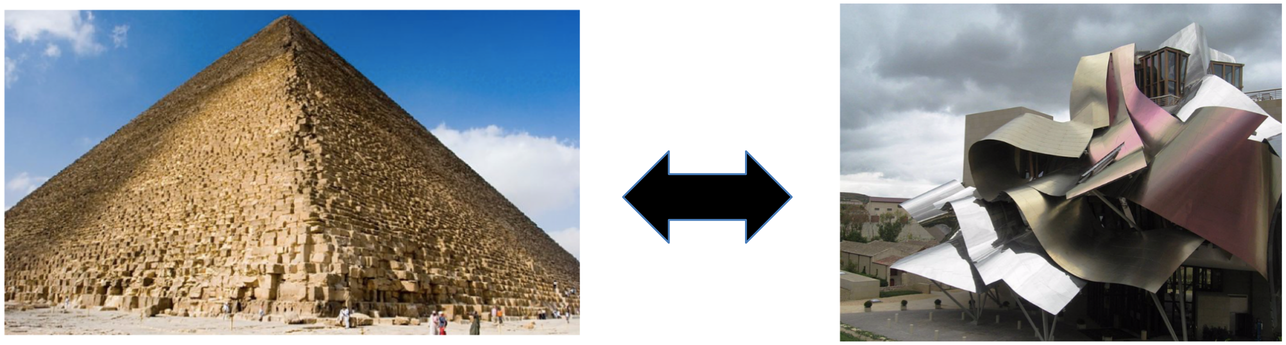
$$\frac{d\sigma}{dT} = \frac{G_F^2 M}{\pi} F^2(Q) \left[(G_V + G_A)^2 + (G_V - G_A)^2 \left(1 - \frac{T}{E_\nu}\right)^2 - (G_V^2 - G_A^2)\frac{MT}{E_\nu^2} \right]$$



At current level of experimental precision, form factor uncertainty is small effect

So: if you are hunting for BSM physics
as a distortion of the recoil spectrum
… **uncertainties in the form factor are a nuisance!**

There are degeneracies in the observables between
"old" (but still mysterious) physics



and "new" physics

We will need to think carefully about how to
disentangle these effects and understand uncertainties,
for the longer term

[See also: D. Aristizabal Sierra et al. arXiv:1902.07398,
recent INT workshop "Weak Elastic Scattering with Nuclei"]

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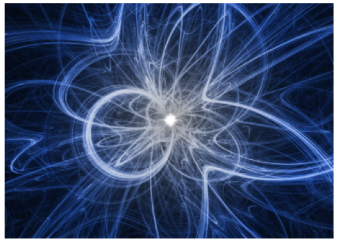

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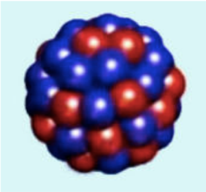

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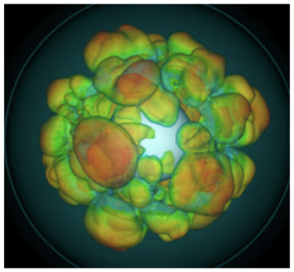

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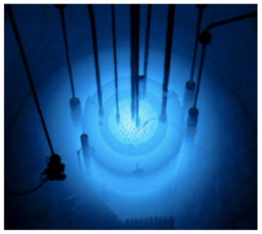
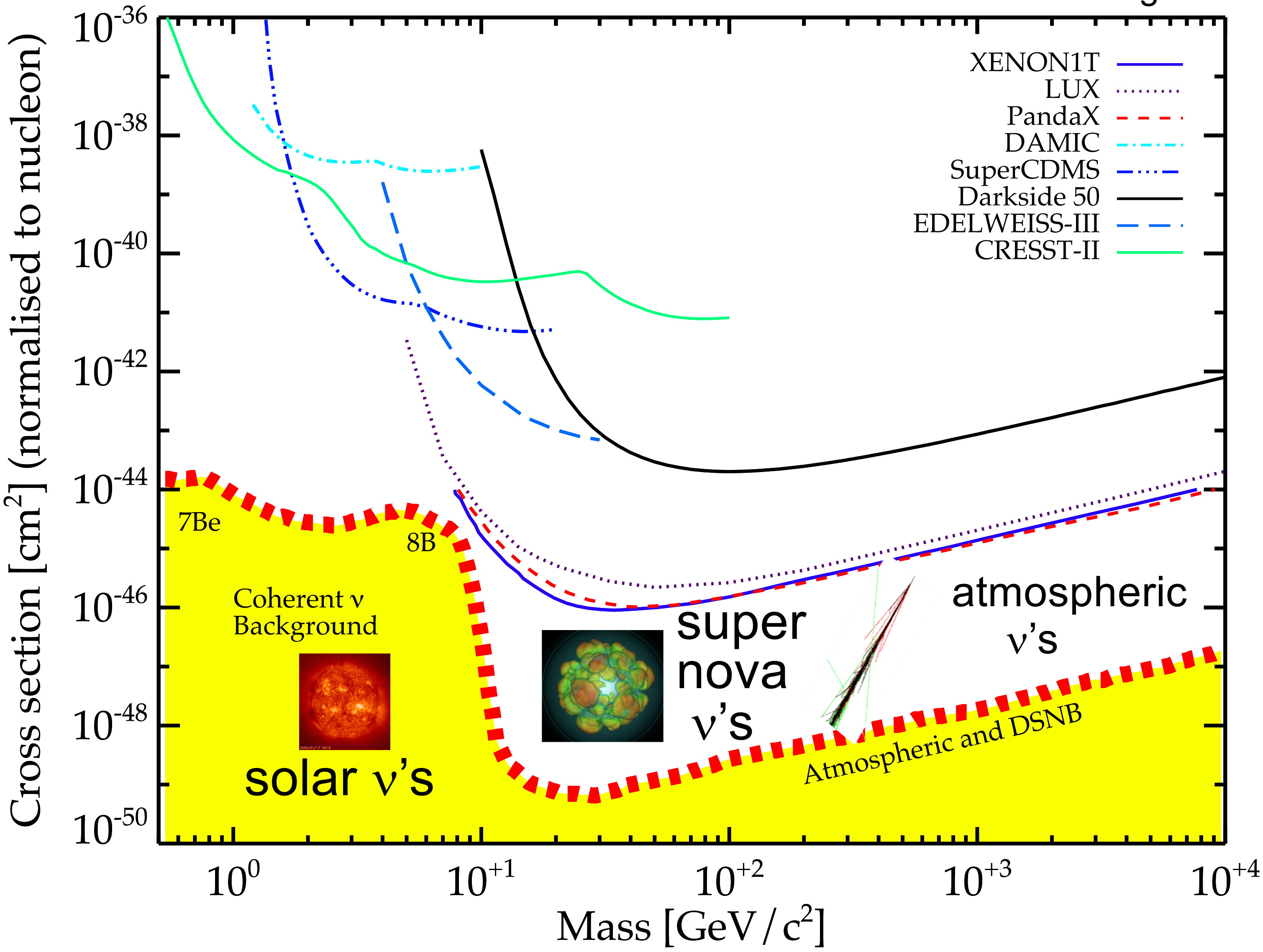


The so-called “neutrino floor” (**signal!**) for direct DM experiments

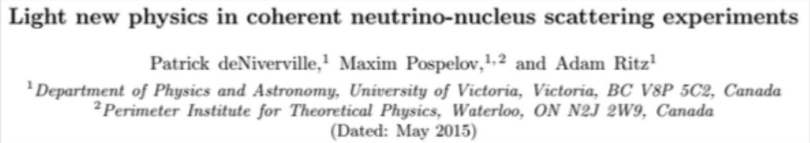
J. Monroe & P. Fisher, 2007

J. Billard, E. Figueroa-Feliciano, and L. Strigari, arXiv:1307.5458v2 (2013).

L. Strigari



Light **accelerator-produced DM** direct detection possibilities
(CEvNS is bg)



Light new physics in coherent neutrino-nucleus scattering experiments

Patrick deNiverville,[1] Maxim Pospelov,[1,2] and Adam Ritz[1]
[1]*Department of Physics and Astronomy, University of Victoria, Victoria, BC V8P 5C2, Canada*
[2]*Perimeter Institute for Theoretical Physics, Waterloo, ON N2J 2W9, Canada*
(Dated: May 2015)

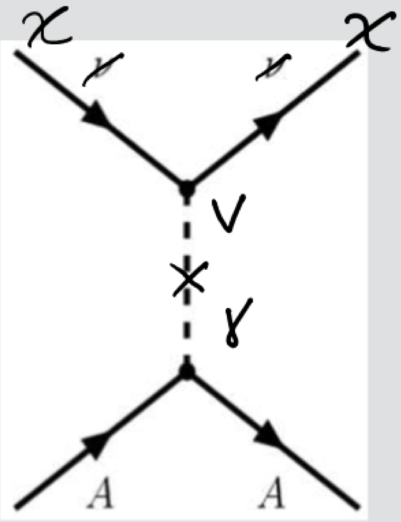
production:

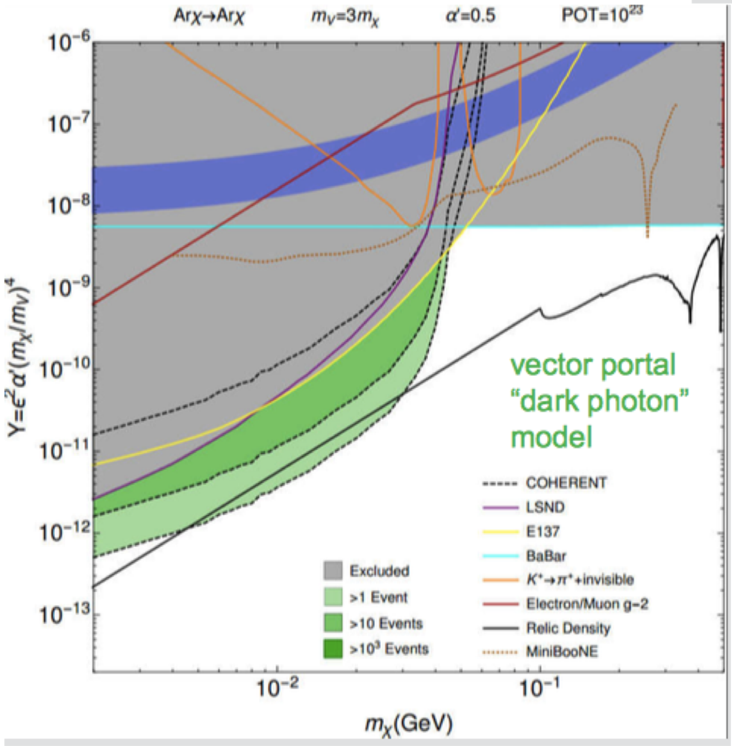
proton → target → $\pi^{0,\pm}$ →

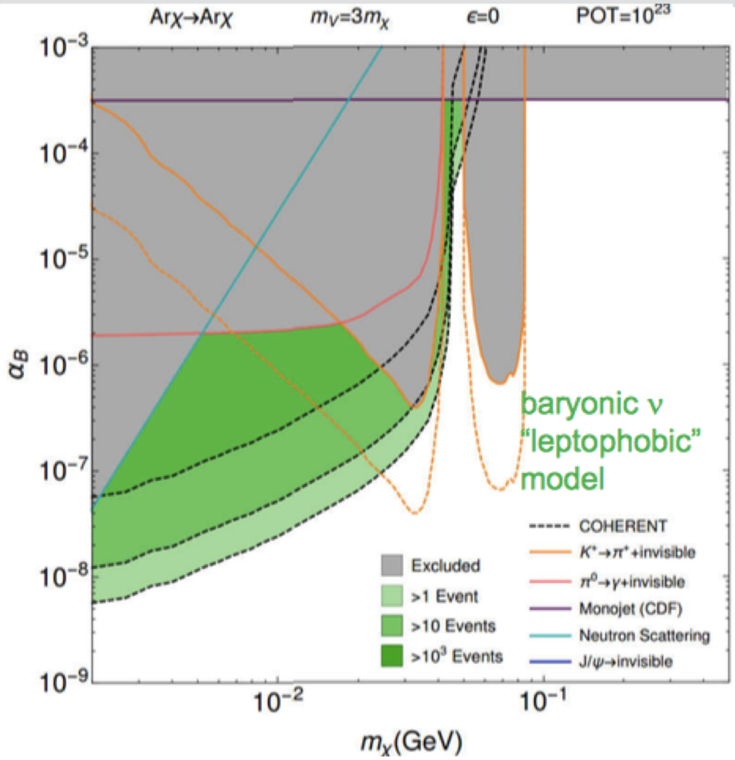
$$\pi^0 \longrightarrow \gamma + V^{(*)} \longrightarrow \gamma + \chi^\dagger + \chi$$

$$\pi^- + p \longrightarrow n + V^{(*)} \longrightarrow n + \chi^\dagger + \chi$$

detection:







1 ton LAr
E_{rec}>20keVnr
10^{23} POT

Summary of what we can get at experimentally

Observables:

Event rate

Recoil spectrum ($T=Q^2/2M$)

[In principle: scattering angle... hard]

Spectral shape systematics are hard!

Knowable/controllable parameters:

Neutrino flavor, via source, and timing

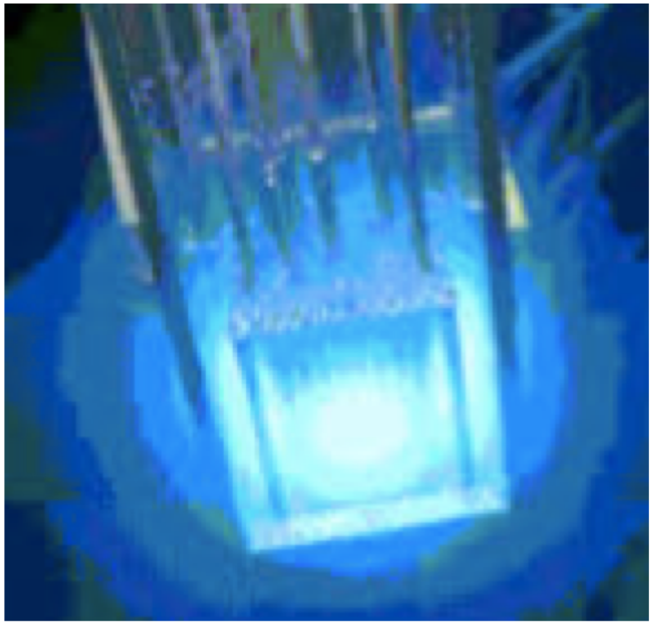
(reactor: ν_e-bar, stopped-π: ν_e, ν_μ-bar, ν_μ)

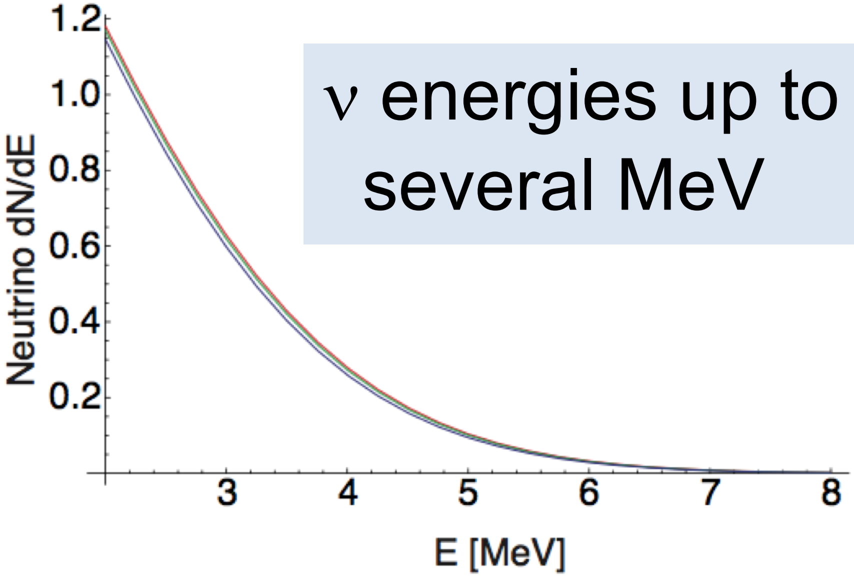
N, Z via nuclear target type

Baseline

Direction with respect to source

Neutrinos from nuclear reactors

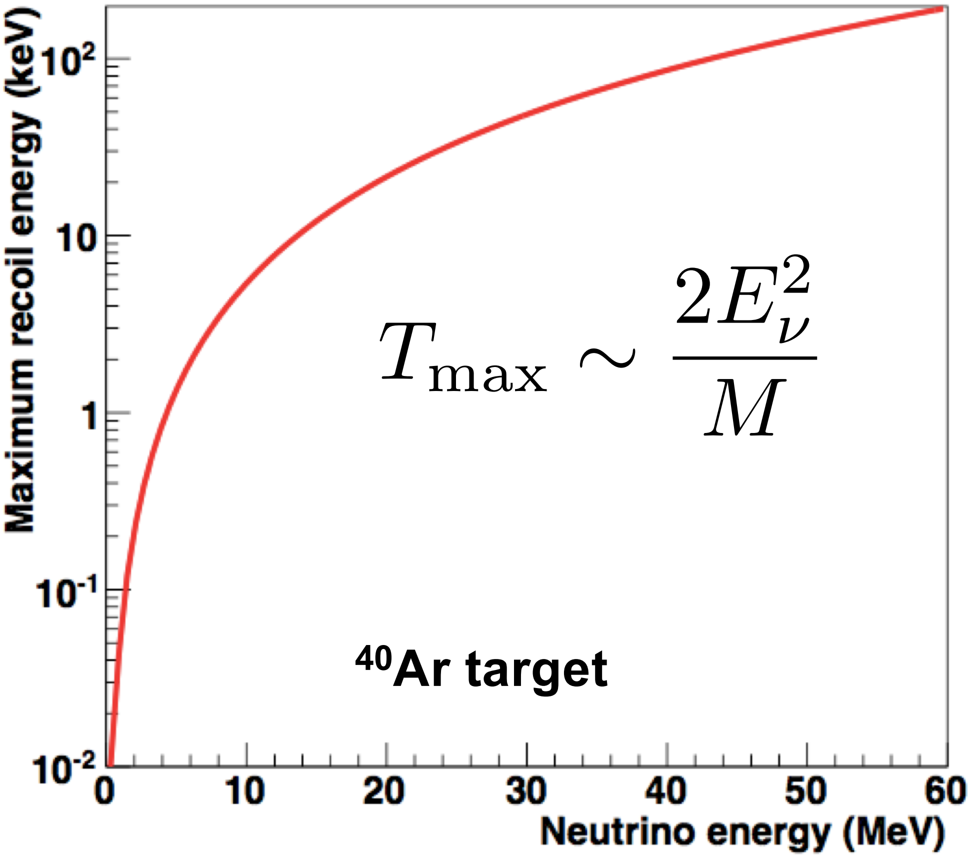


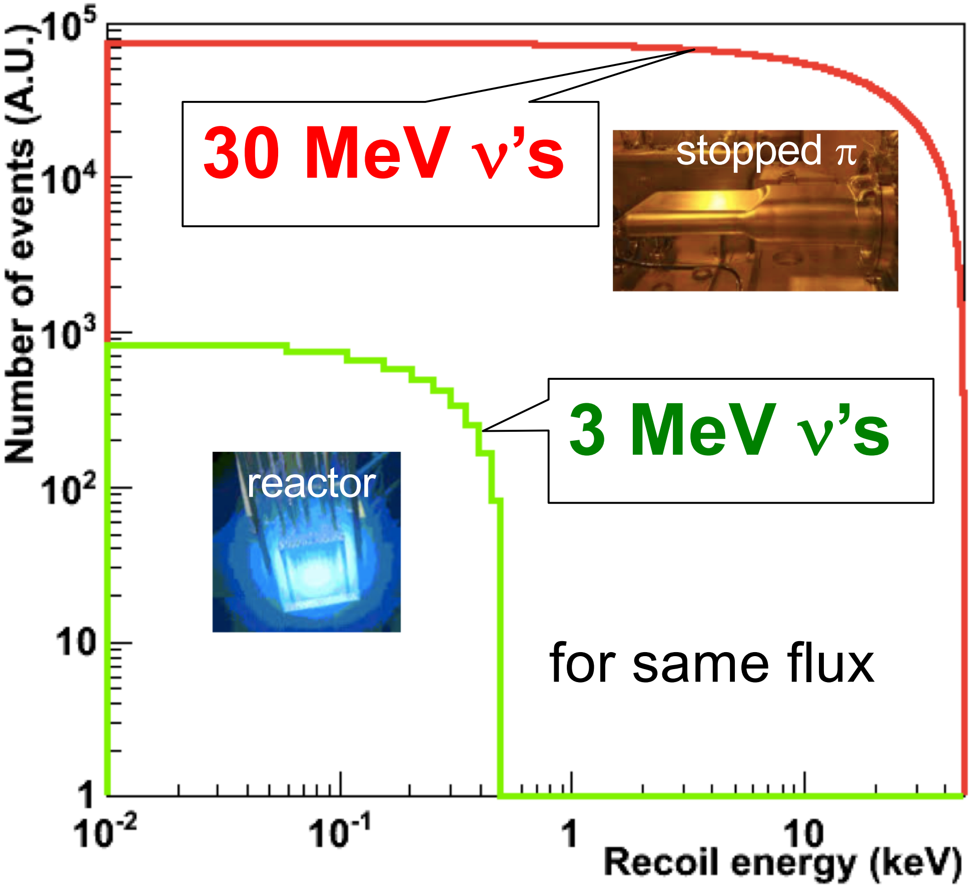


ν energies up to several MeV

- ν_e-bar produced in fission reactions (one flavor)
- **huge fluxes possible**: ~2x10^{20} s^{-1} per GW
- several CEvNS searches past, current and future at reactors, but **recoil energies<keV** and backgrounds make this very challenging

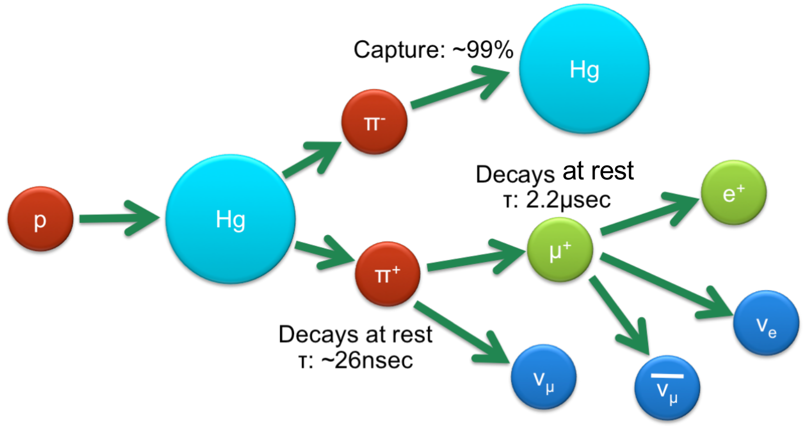
Both **cross-section** and **maximum recoil energy increase with neutrino energy**:

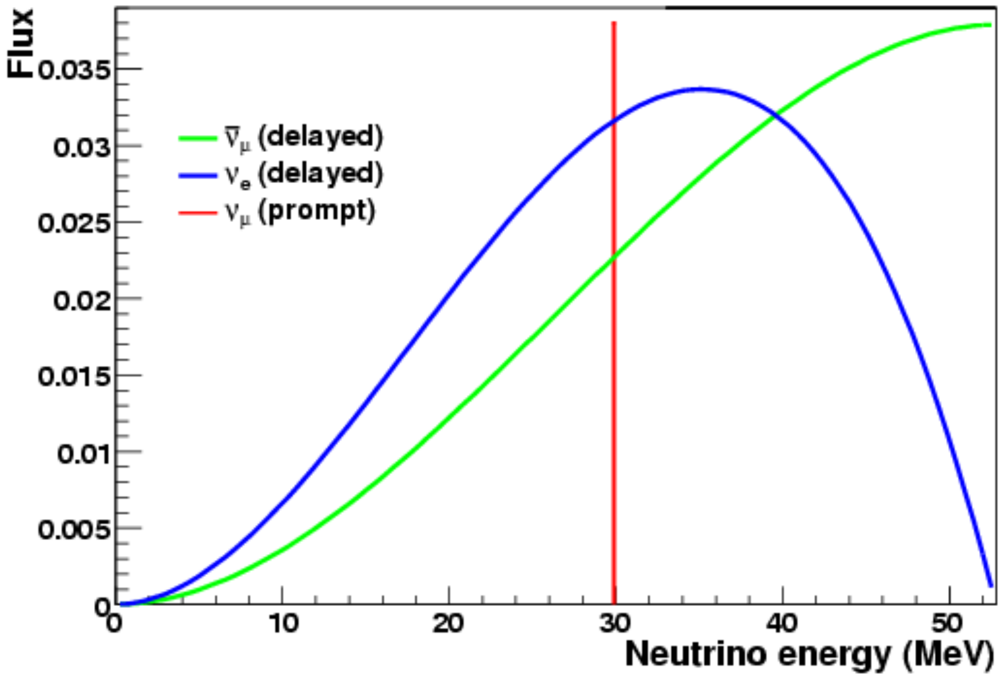




Want energy as large as possible while satisfying coherence condition: $Q \lesssim \frac{1}{R}$ (<~ 50 MeV for medium A)

Stopped-Pion (πDAR) Neutrinos





$$\pi^+ \longrightarrow \mu^+ + \nu_\mu$$

2-body decay: monochromatic 29.9 MeV ν_μ
PROMPT

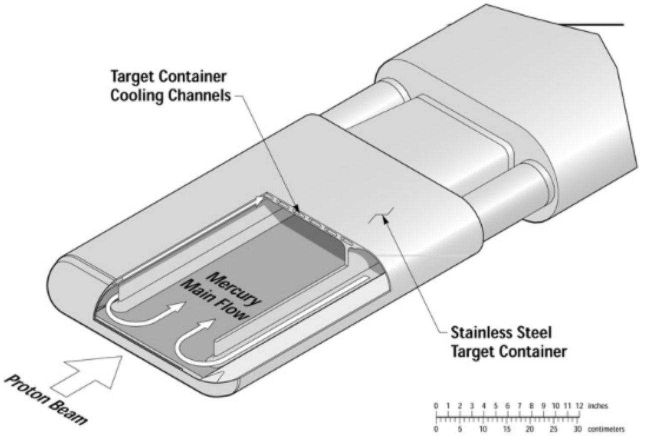
$$\downarrow$$

$$\mu^+ \longrightarrow e^+ + \bar{\nu}_\mu + \nu_e$$

3-body decay: range of energies
between 0 and $m_\mu/2$
DELAYED (2.2 μs)

Spallation Neutron Source

Oak Ridge National Laboratory, TN



Proton beam energy: 0.9-1.3 GeV
Total power: 0.9-1.4 MW
Pulse duration: 380 ns FWHM
Repetition rate: 60 Hz
Liquid mercury target

The neutrinos are free!

The COHERENT collaboration

`http://sites.duke.edu/coherent`

~90 members,
20 institutions
4 countries

`arXiv:1509.08702`

U.S. DEPARTMENT OF ENERGY
Office of Science
NSF
KICP
NNSA
National Nuclear Security Administration
CNEC

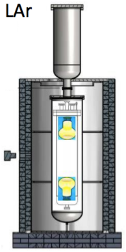
COHERENT
SNS
SPALLATION NEUTRON SOURCE

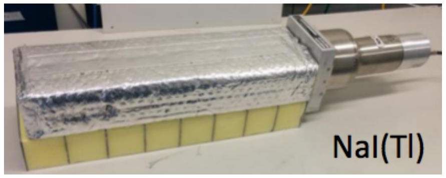
Carnegie Mellon University
THE UNIVERSITY OF CHICAGO
Duke UNIVERSITY
UF UNIVERSITY of FLORIDA
KAIST
Laurentian University
Université Laurentienne
Los Alamos NATIONAL LABORATORY EST. 1943
MEPhI
NORTH CAROLINA CENTRAL UNIVERSITY FOUNDED 1910
NC STATE UNIVERSITY
NM STATE UNIVERSITY
OAK RIDGE National Laboratory
Sandia National Laboratories
THE UNIVERSITY of TENNESSEE UT KNOXVILLE
TUNL
W UNIVERSITY of WASHINGTON
Tufts UNIVERSITY
VT VIRGINIA TECH
SD UNIVERSITY OF SOUTH DAKOTA

COHERENT CEvNS Detectors

Nuclear Target	Technology	Mass (kg)	Distance from source (m)	Recoil threshold (keVr)
CsI[Na]	Scintillating crystal flash	14.6	19.3	6.5
Ge	HPGe PPC zap	16	22	<few
LAr	Single-phase flash	22	29	20
NaI[Tl]	Scintillating crystal flash	185*/3338	28	13

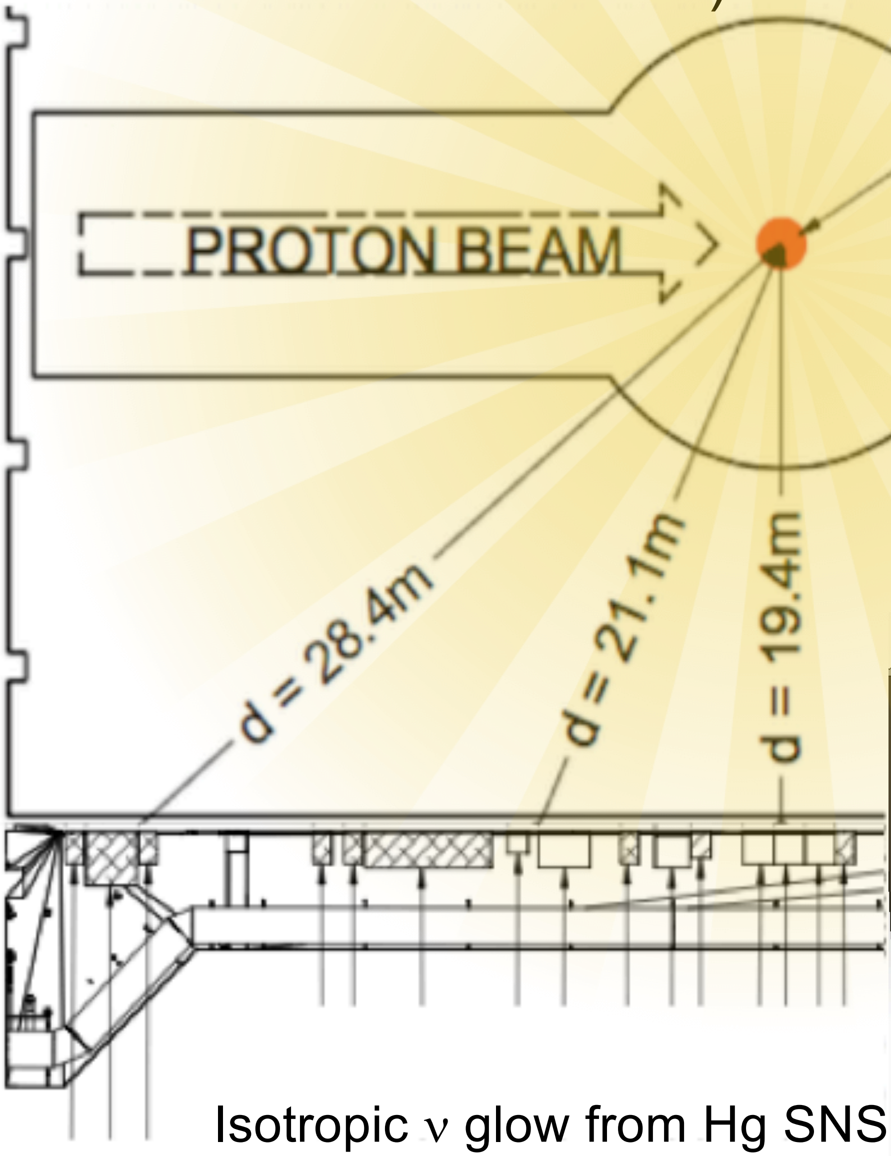
Multiple detectors for N^2 dependence of the cross section





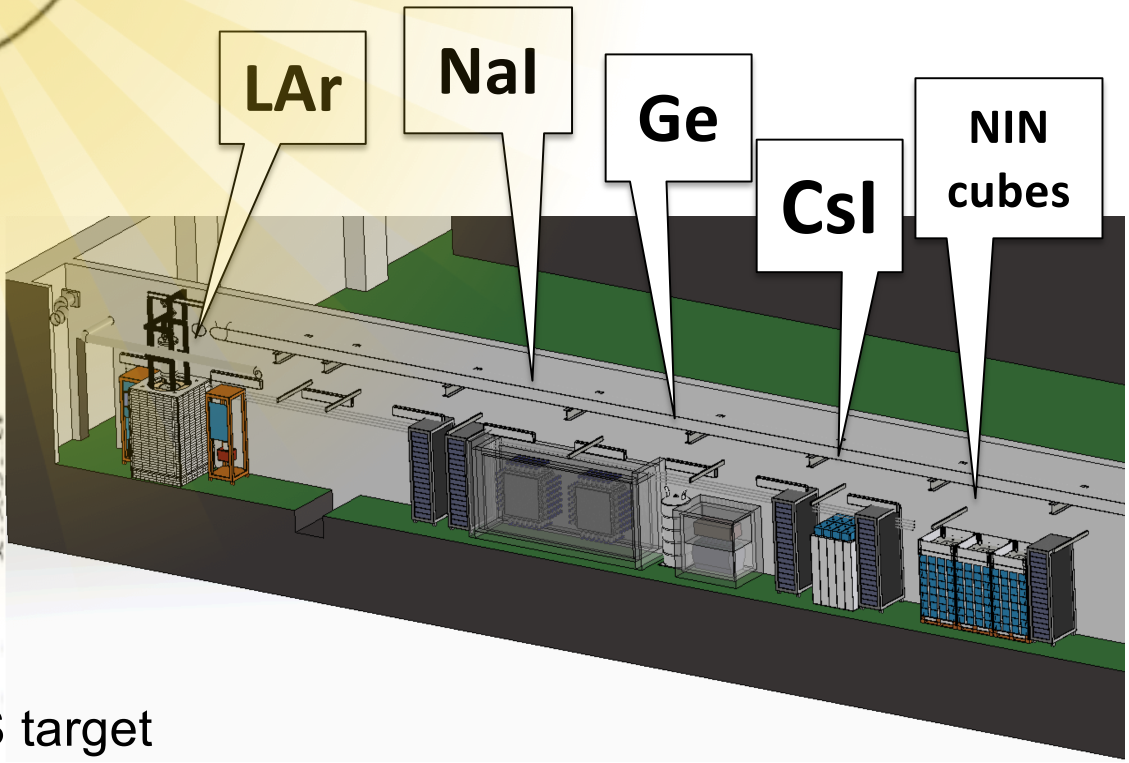
Siting for deployment in SNS basement

(measured neutron backgrounds low,
~ 8 mwe overburden)

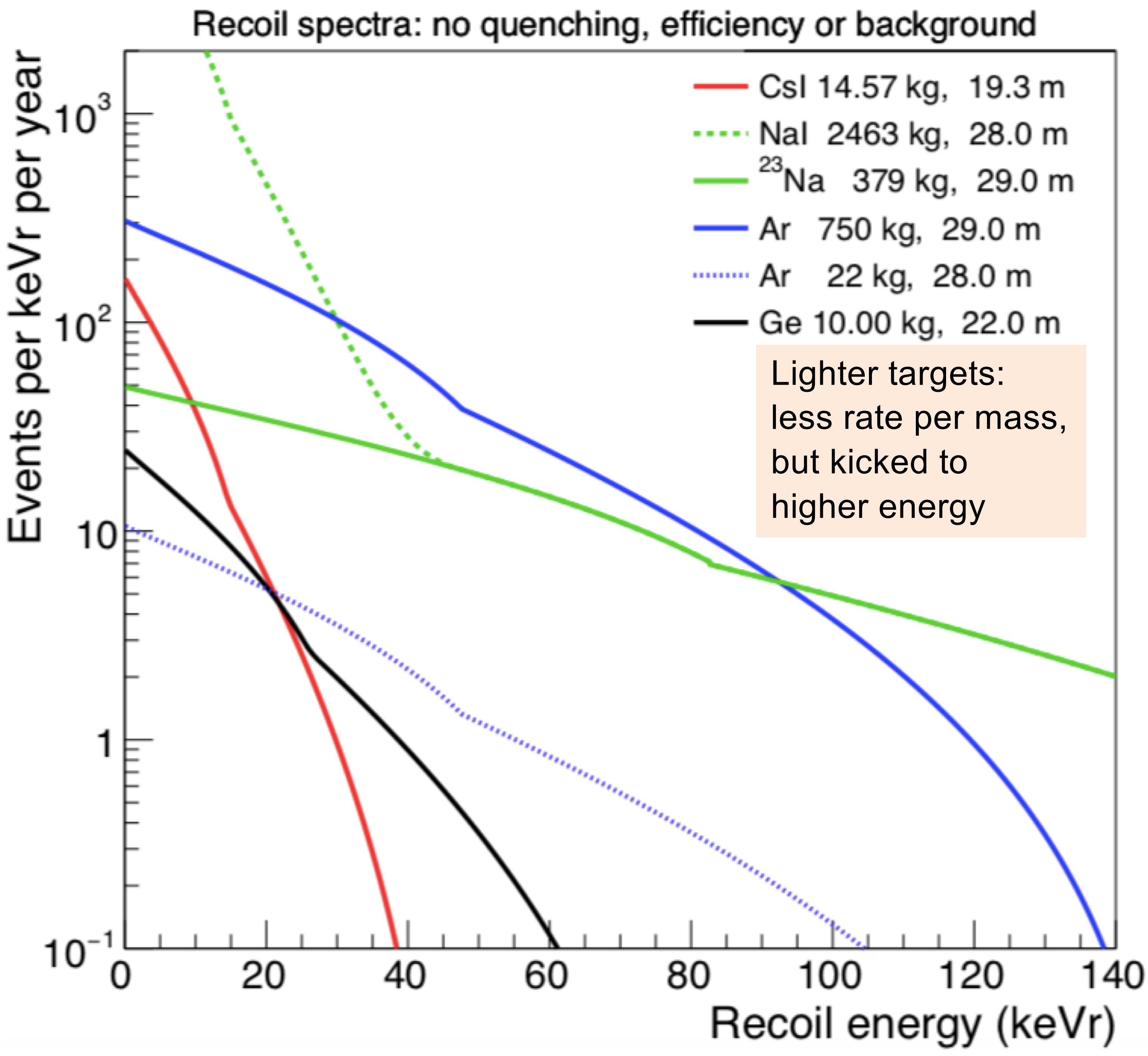


Isotropic ν glow from Hg SNS target

View looking
down “Neutrino Alley”

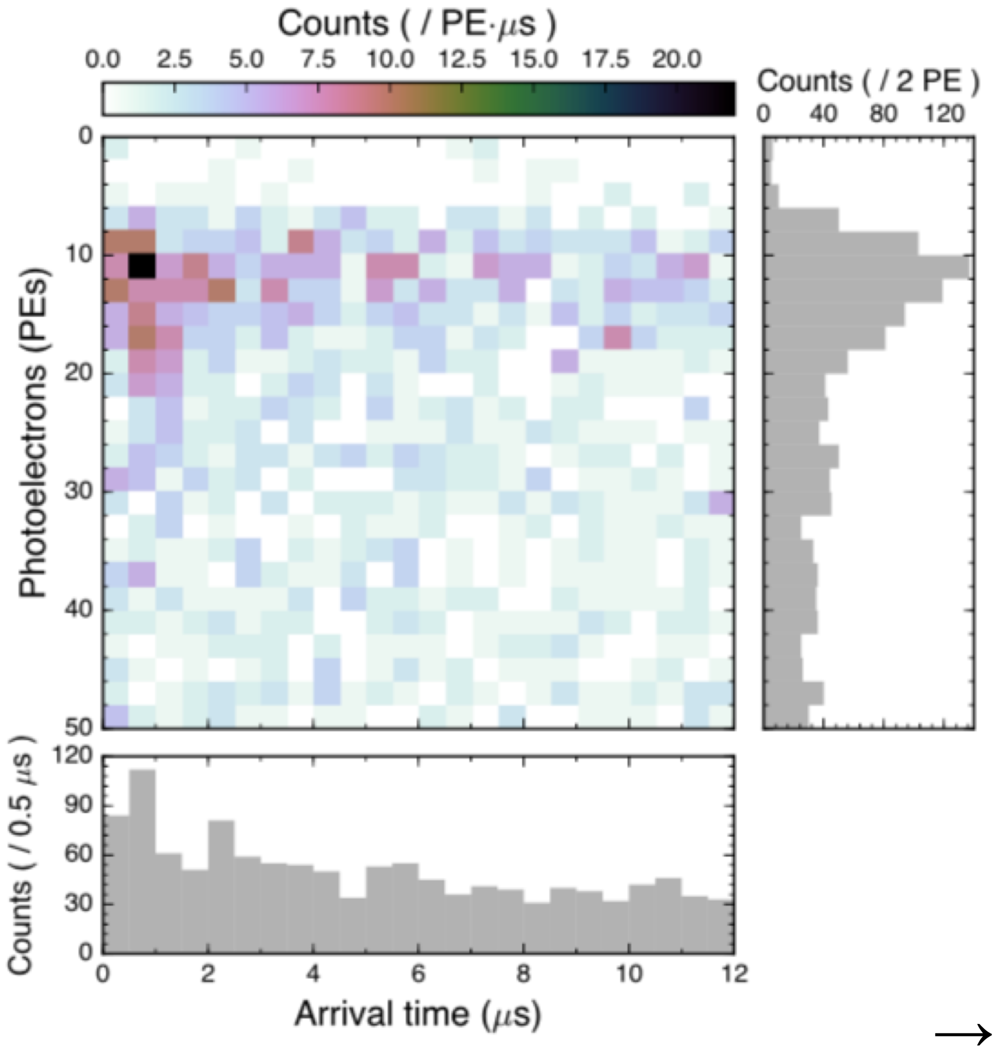


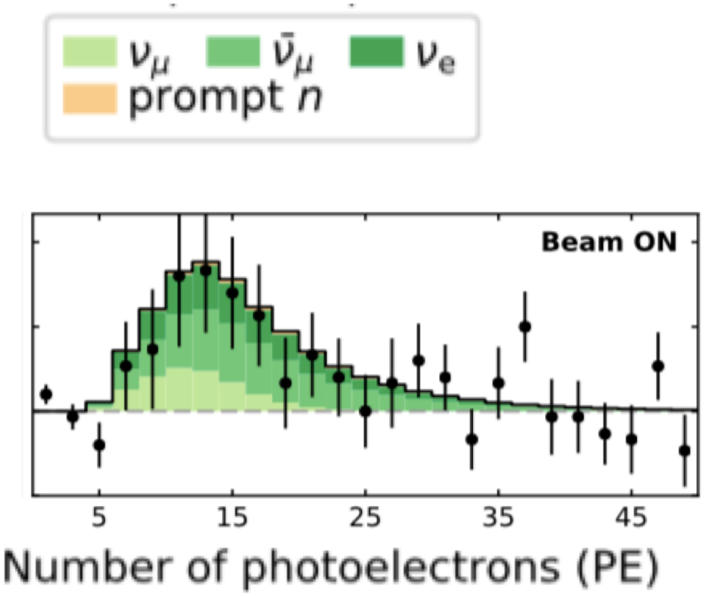
Expected recoil energy distribution



Lighter targets: less rate per mass, but kicked to higher energy

First light at the SNS (stopped-pion neutrinos) with 14.6-kg CsI[Na] detector





Background-subtracted and integrated over time

$$\mathrm{PE} \propto T \propto Q^2$$

→ measure of the Q spectrum

DOI: 10.5281/zenodo.1228631

D. Akimov et al., *Science*, 2017
http://science.sciencemag.org/content/early/2017/08/02/science.aao0990

Signal, background, and uncertainty summary numbers

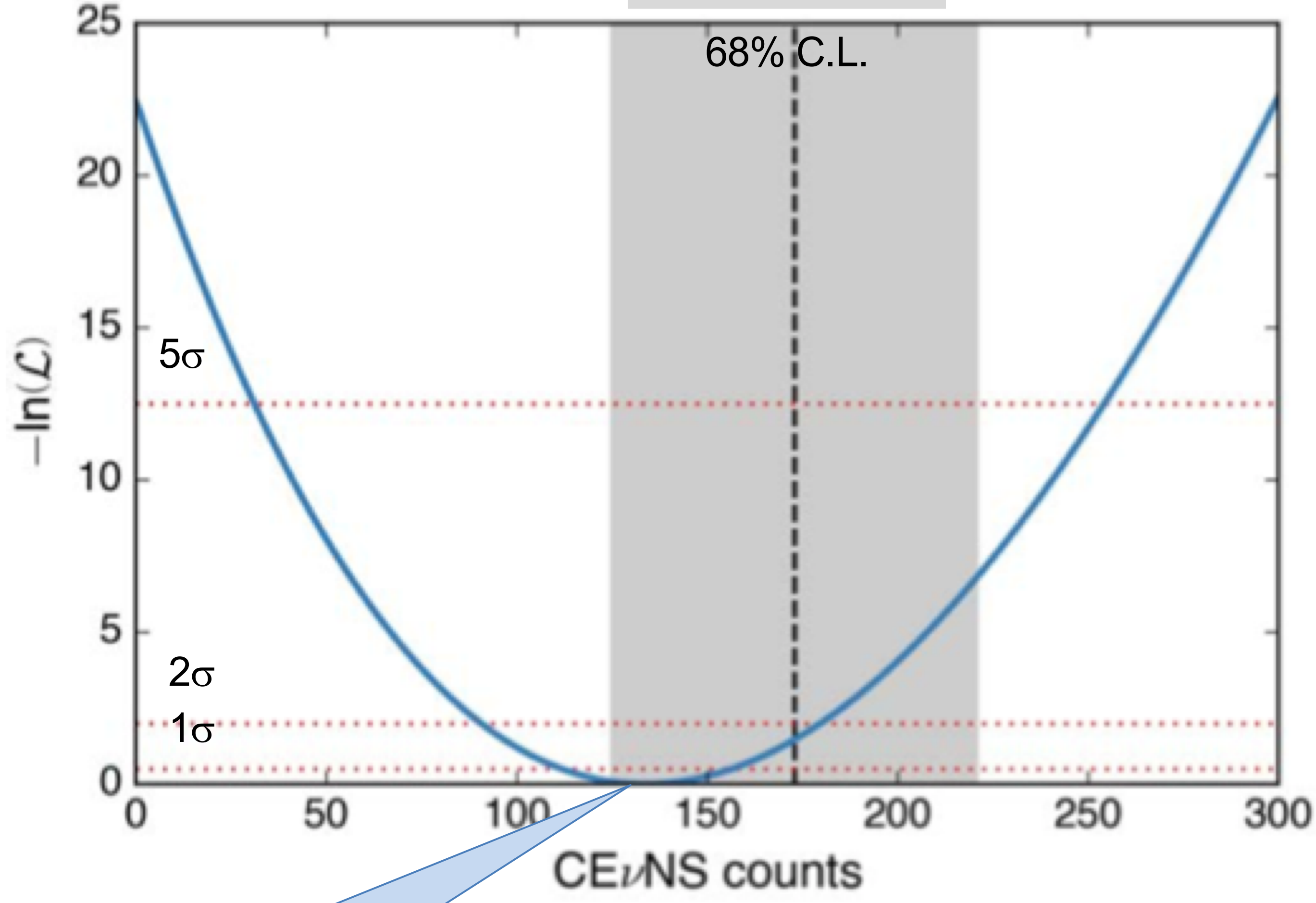
$6 \leq \text{PE} \leq 30,\ 0 \leq t \leq 6000$ ns

Beam ON coincidence window	547 counts
Anticoincidence window	405 counts
Beam-on bg: prompt beam neutrons	7.0 ± 1.7
Beam-on bg: NINs (neglected)	4.0 ± 1.3
Signal counts, single-bin counting	136 ± 31
Signal counts, 2D likelihood fit	**134 ± 22**
Predicted SM signal counts	**173 ± 48**

Uncertainties on signal and background predictions	
Event selection	5%
Flux	10%
Quenching factor	25%
Form factor	5%
Total uncertainty on signal	**28%**
Beam-on neutron background	25%

Dominant uncertainty

Results of 2D energy, time fit

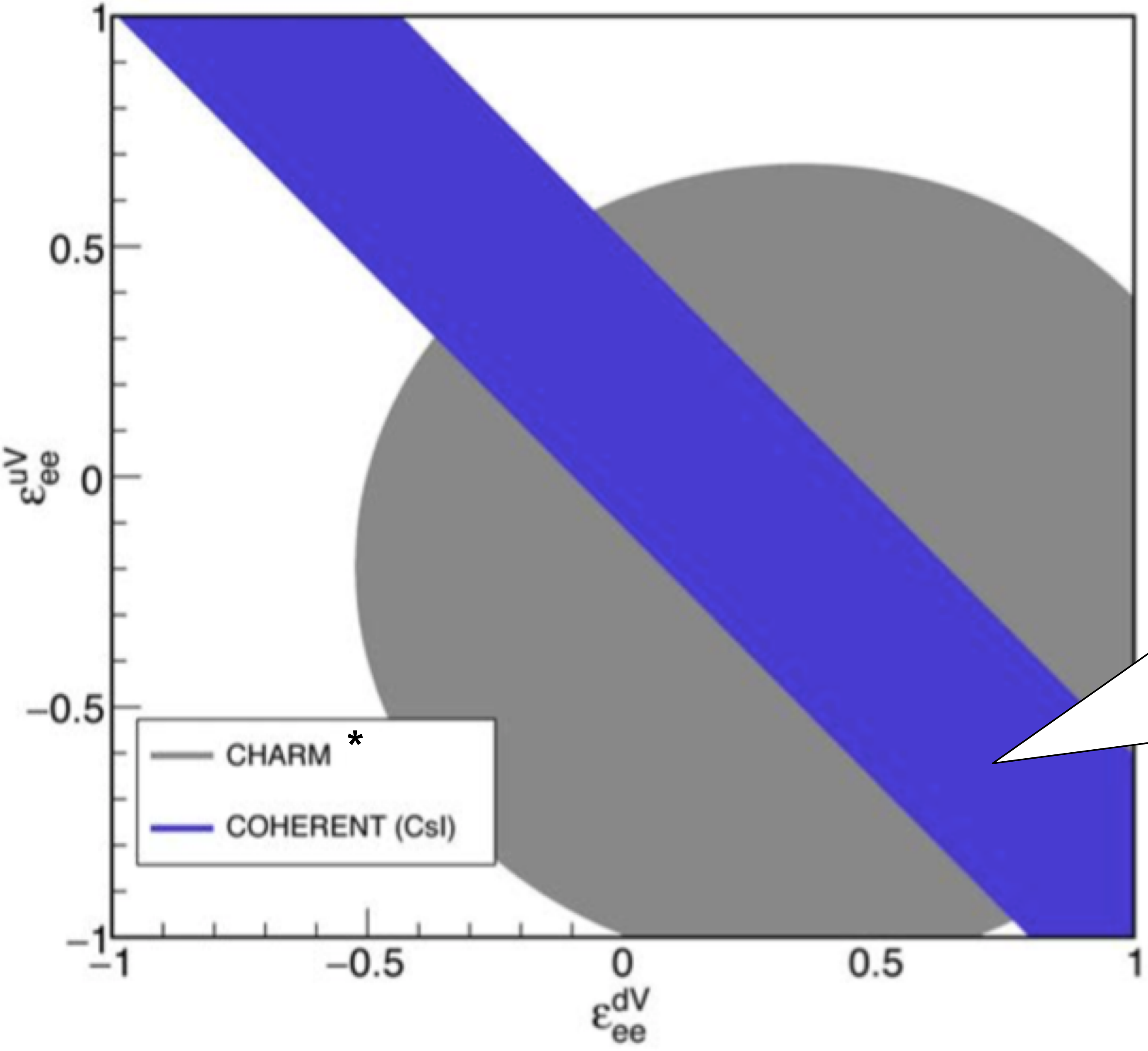


SM prediction, 173 events

Best fit: **134 ± 22** observed events

No CEvNS rejected at 6.7σ, consistent w/SM within 1σ

Neutrino non-standard interaction constraints for current CsI data set:

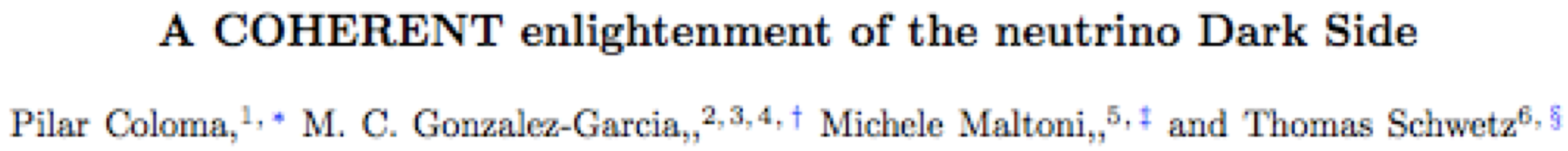


- Assume all other ε's zero

Parameters describing beyond-the-SM interactions outside this region disfavored at 90%

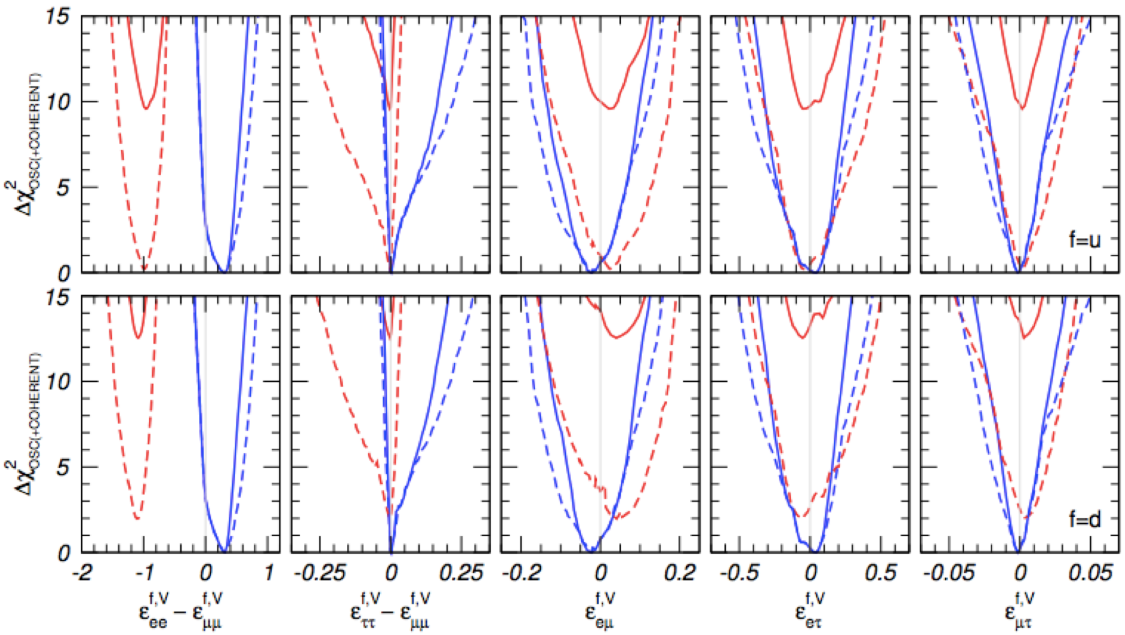
See also Coloma et al., arXiv:1708.02899

*CHARM constraints apply only to heavy mediators



A COHERENT enlightenment of the neutrino Dark Side

Pilar Coloma,[1,*] M. C. Gonzalez-Garcia,,[2,3,4,†] Michele Maltoni,,[5,‡] and Thomas Schwetz[6,§]



Global fits to COHERENT + oscillation experiments

Solid: COHERENT

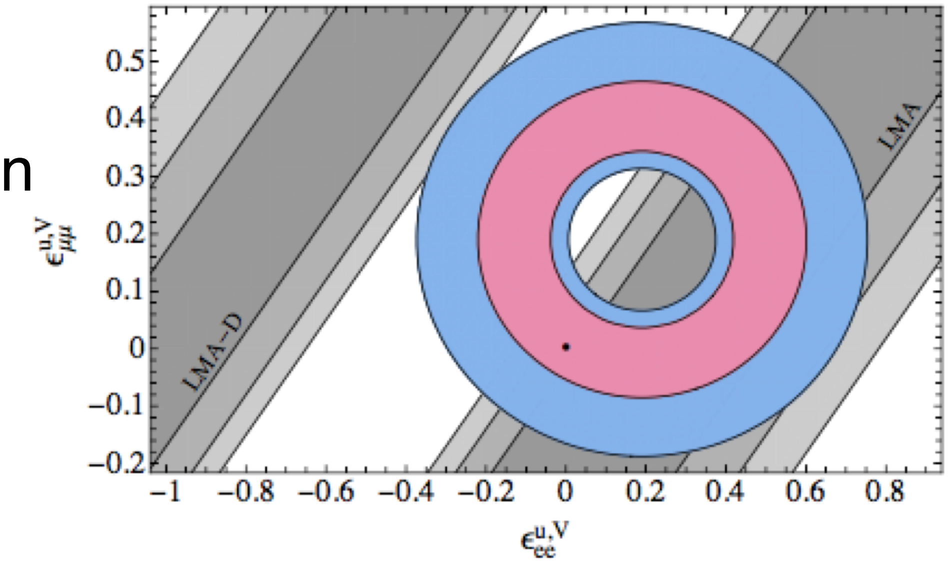
Dashed: COHERENT + osc

Blue: LMA ($\theta_{12} < \pi/4$)

Red: LMA-D ($\theta_{12} > \pi/4$)

(“dark side”, still allowed with NSI)

1σ, 2σ allowed regions projected in (ε_{ee}^{uV}, $\varepsilon_{\mu\mu}^{uV}$) plane



Already meaningful constraints!

Another phenomenological analysis, making use of spectral fit:

COHERENT constraints on nonstandard neutrino interactions

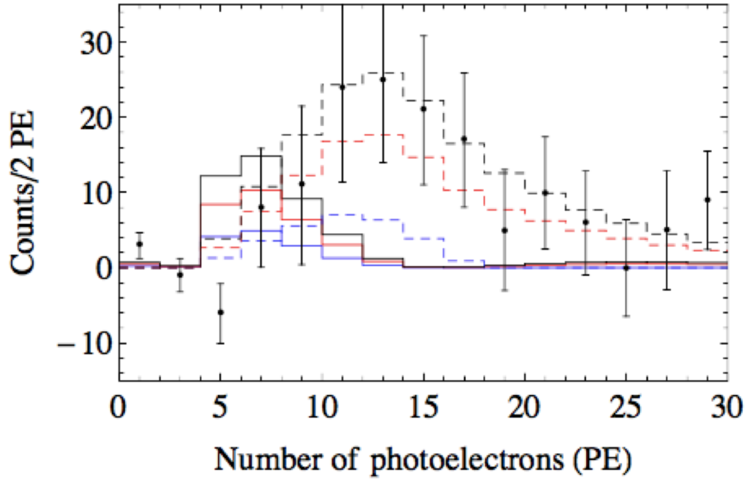
Jiajun Liao and Danny Marfatia
arXiv:1708.04255

SM weak charge

Effective weak charge in presence of light vector mediator Z'

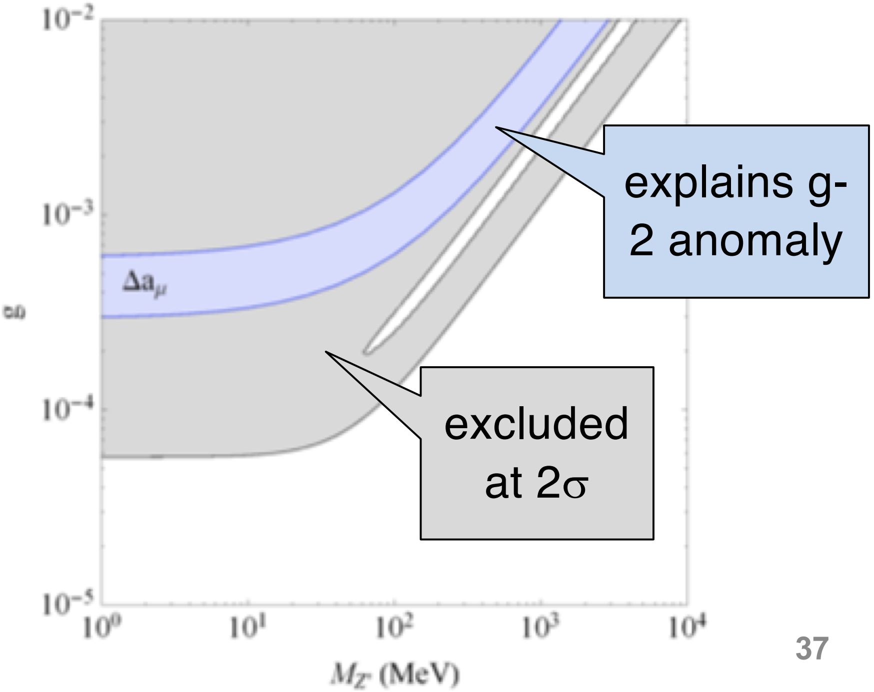
$$Q^2_{\alpha,\mathrm{SM}} = (Zg_p^V + Ng_n^V)^2 \quad \Rightarrow \quad Q^2_{\alpha,\mathrm{NSI}} = \left[Z\left(g_p^V + \frac{3g^2}{2\sqrt{2}G_F(Q^2+M_{Z'}^2)}\right) + N\left(g_n^V + \frac{3g^2}{2\sqrt{2}G_F(Q^2+M_{Z'}^2)}\right)\right]^2$$

- Q^2-dependence ➔ *affects recoil spectrum*
- 2 parameters: g, $M_{Z'}$



Dashed: SM
Solid: NSI w/ $M_{Z'}$= 10 MeV, g=10^{-4}

Blue: ν_μ
Red: ν_μ + ν_μ_bar
Black: ν_μ + ν_μ_bar + ν_e



explains g-2 anomaly

excluded at 2σ

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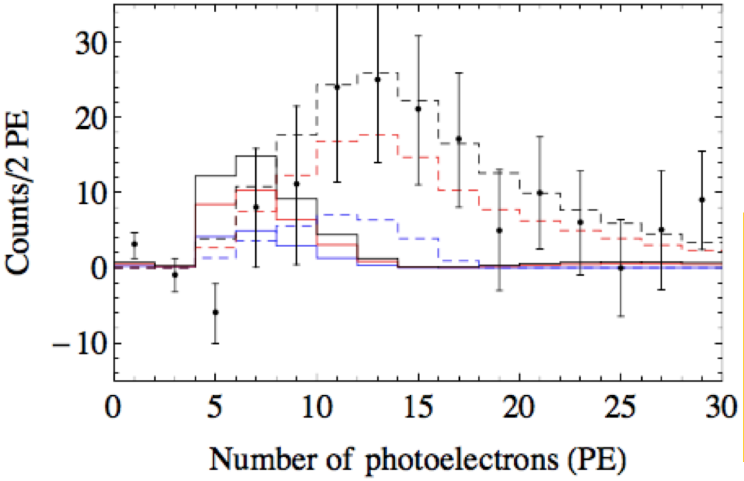

Spectral shape systematics are hard!

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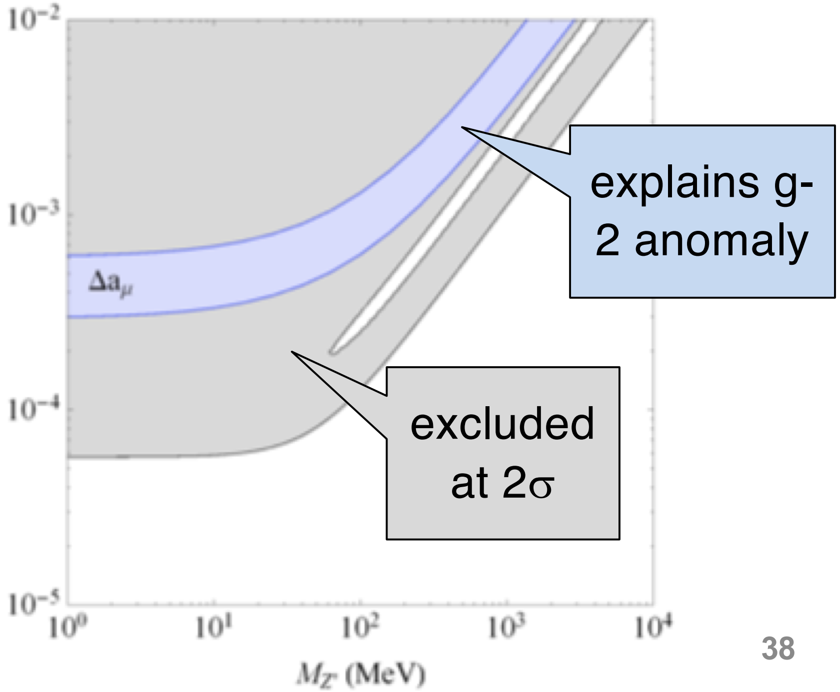

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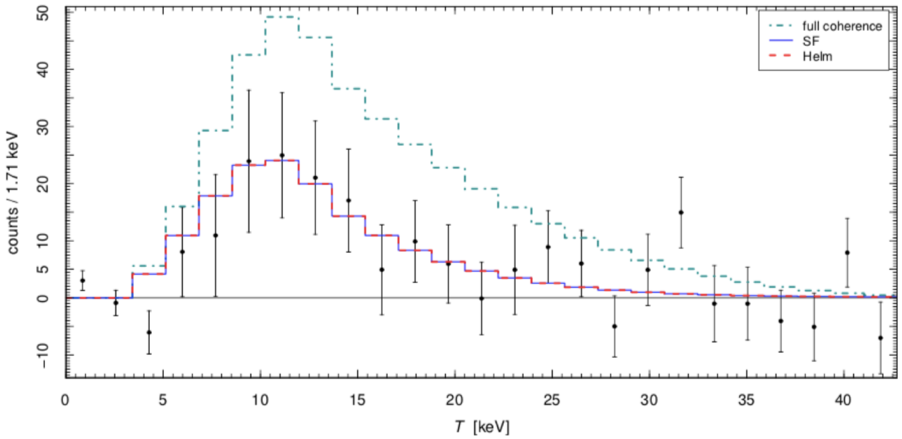
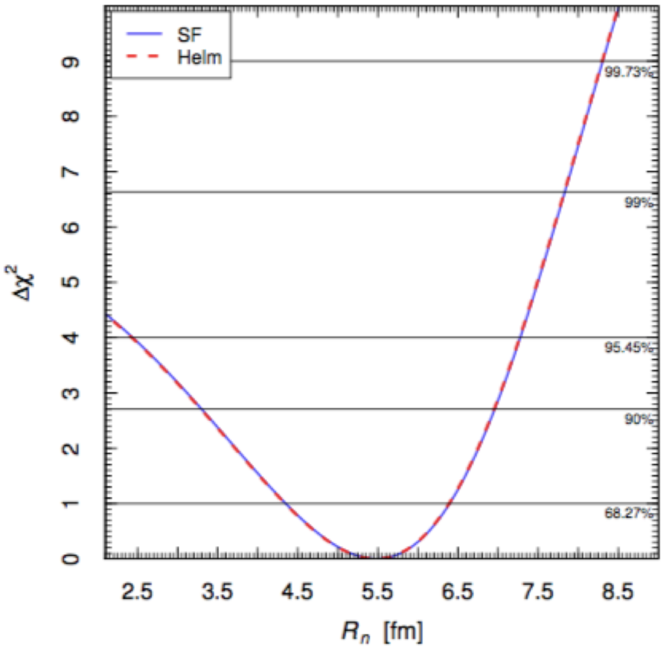
First fit to the COHERENT CsI data

M. Cadeddu, C. Giunti, Y. F. Li, and Y. Y. Zhang. "Average CsI neutron density distribution from COHERENT data." (2017). 1710.02730.





Helm functional form

$$F_N^{\mathrm{Helm}}(q^2) = 3\,\frac{j_1(qR_0)}{qR_0}\,e^{-q^2 s^2/2},$$

$$\boxed{R_n = 5.5^{+0.9}_{-1.1}\ \mathrm{fm}. \qquad \Delta R_{np} \simeq 0.7^{+0.9}_{-1.1}\ \mathrm{fm}.}$$

- Fit to neutron radius resulting in ~18% uncertainty, as well as neutron skin measurement
- Does not handle bin-by-bin correlation of systematics (e.g., from QF)

COHERENT will have better measurement soon,
+ handling of shape systematics w/ correlations

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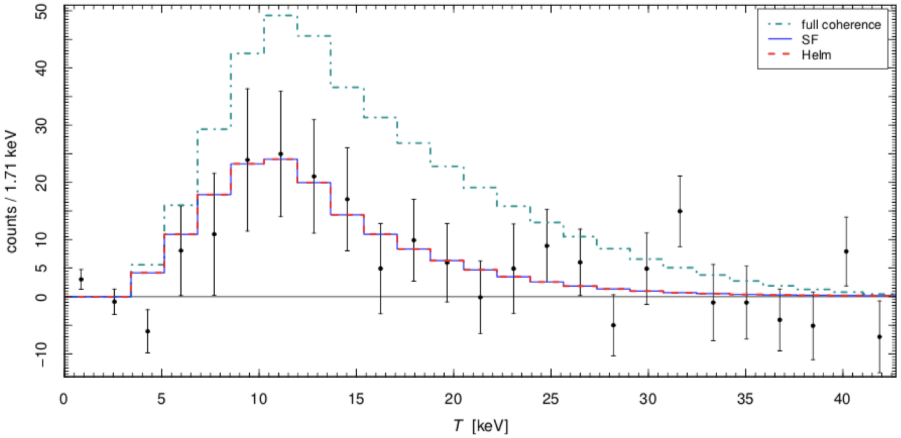

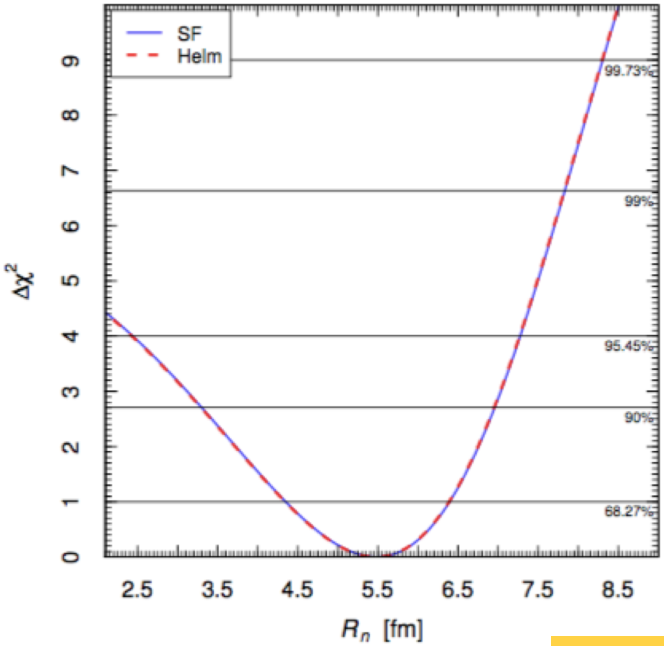

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- Does not handle bin-by-bin correlation of systematics (e.g., from QF)

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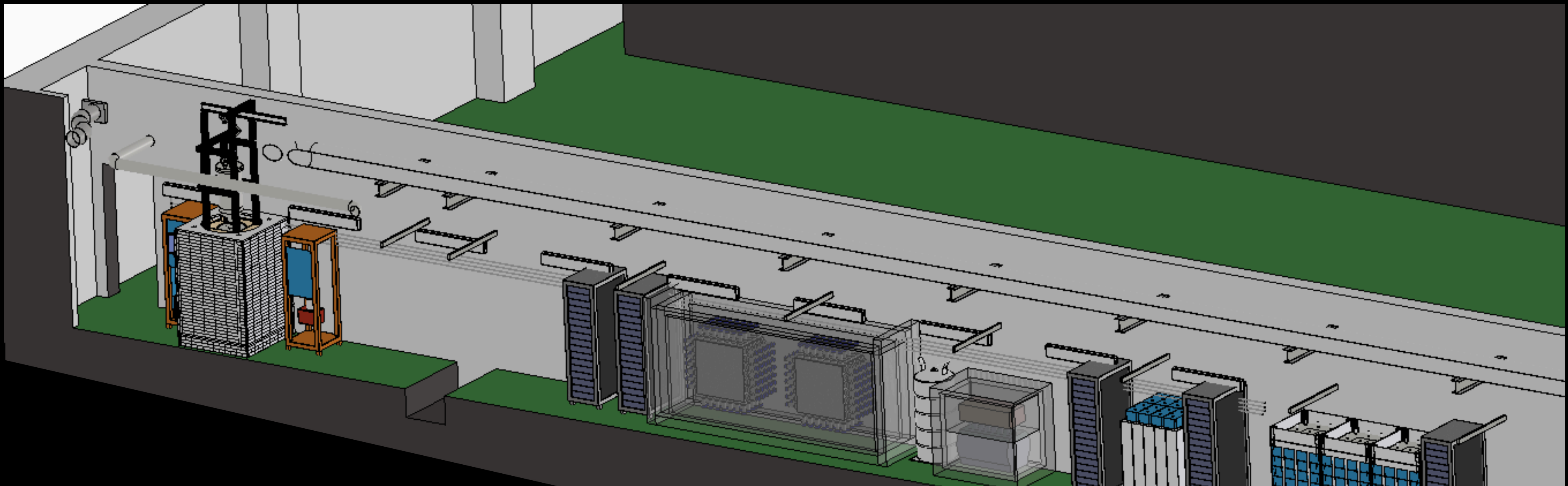
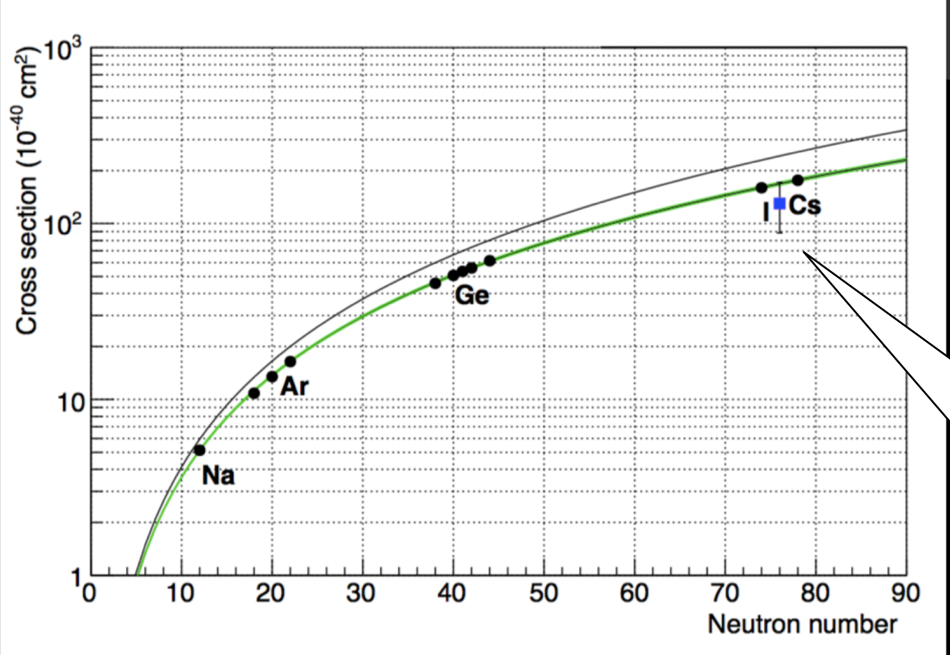
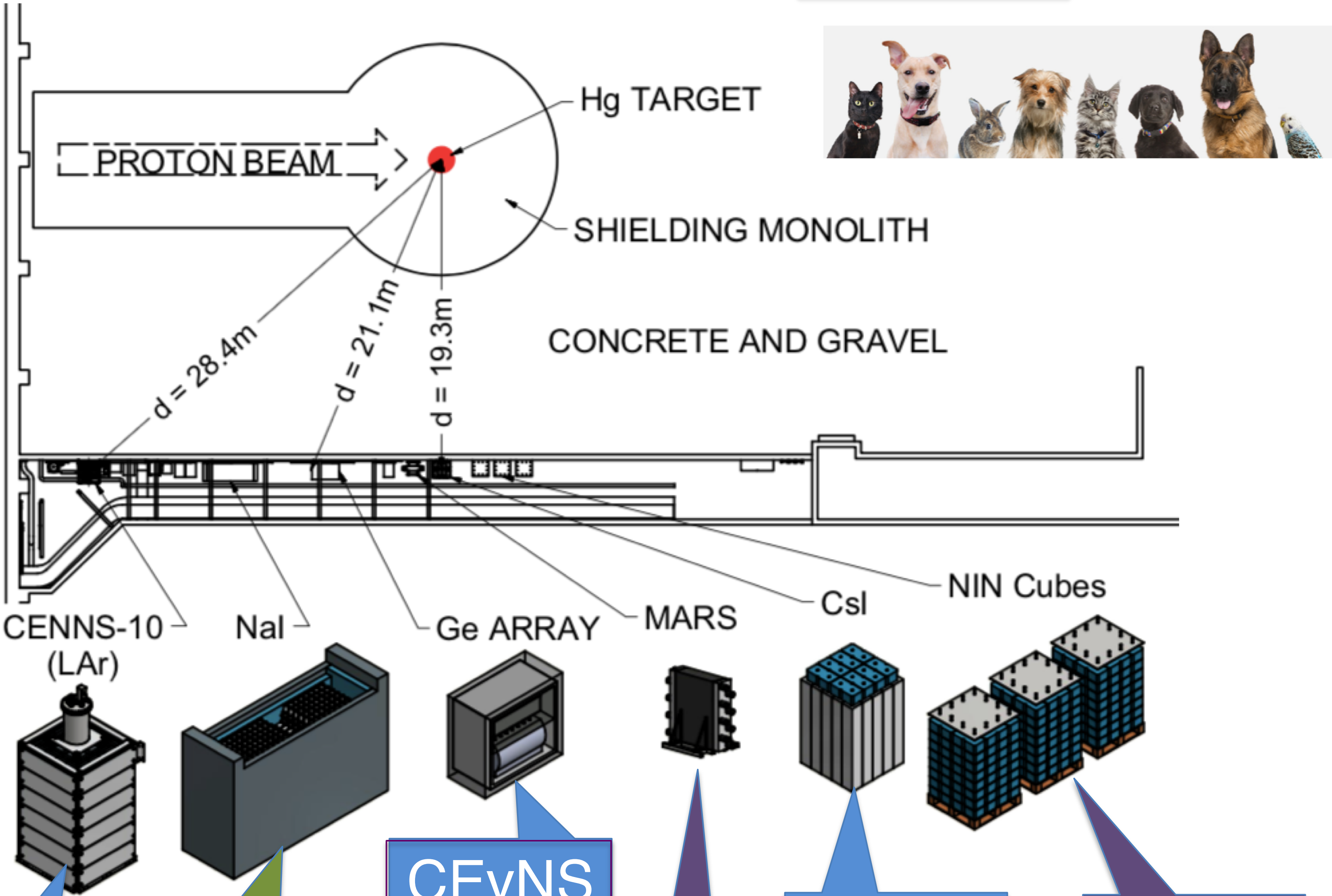
What’s Next for COHERENT?





One measurement so far! Want to map out N^2 dependence

Neutrino Alley Deployments: current & near future



CEvNS

ν_eCC on ^{127}I

CEvNS

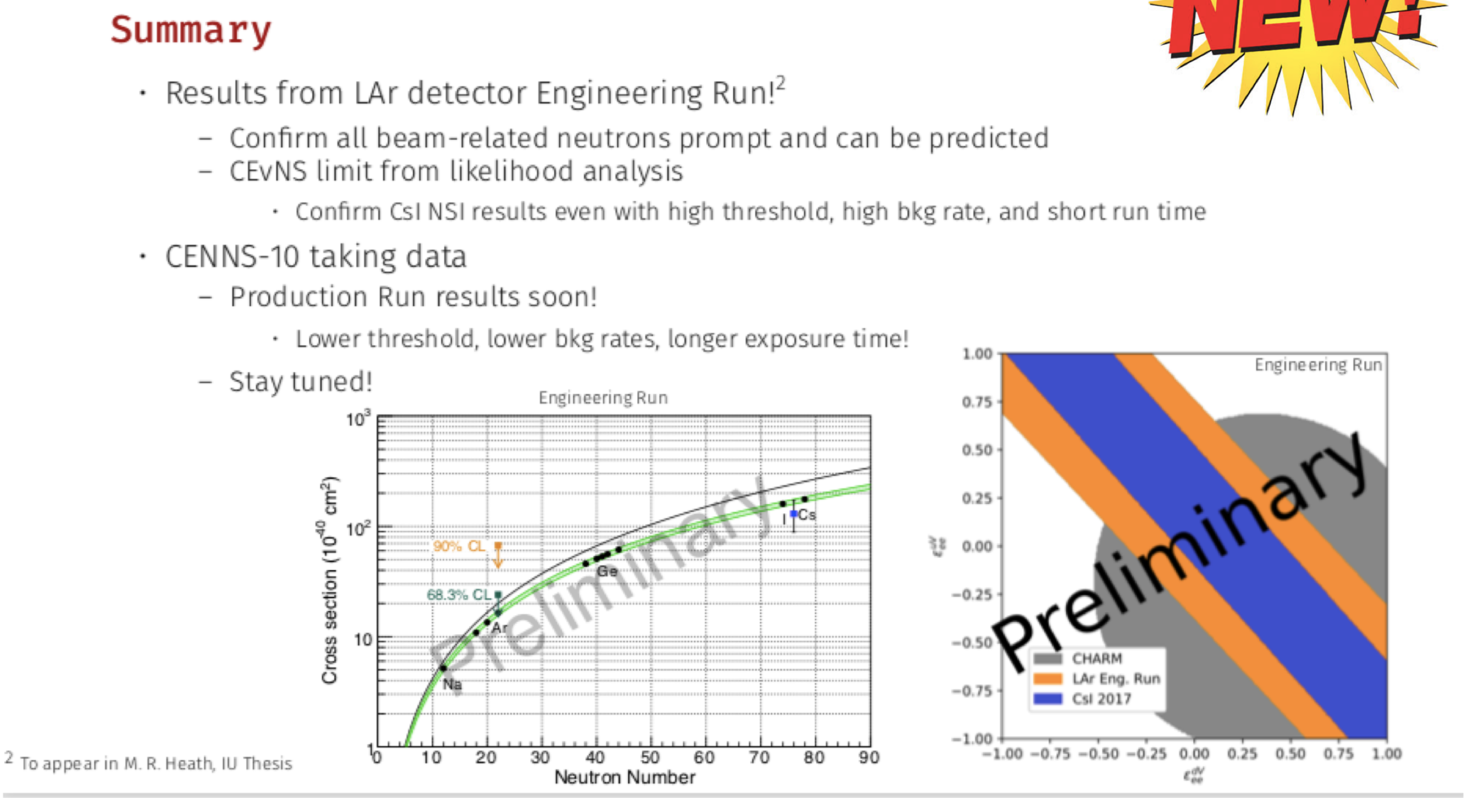
CEvNS

Neutron backgrounds

CEvNS

Neutrino-induced neutrons

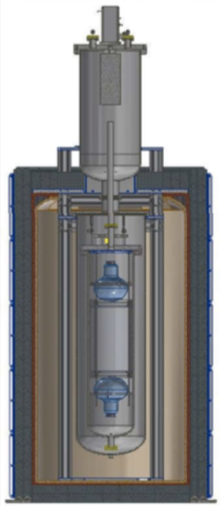
Matt Heath, Indiana U., APS April meeting



Summary

- Results from LAr detector Engineering Run![2]
  - Confirm all beam-related neutrons prompt and can be predicted
  - CEvNS limit from likelihood analysis
    - Confirm CsI NSI results even with high threshold, high bkg rate, and short run time
- CENNS-10 taking data
  - Production Run results soon!
    - Lower threshold, lower bkg rates, longer exposure time!
  - Stay tuned!

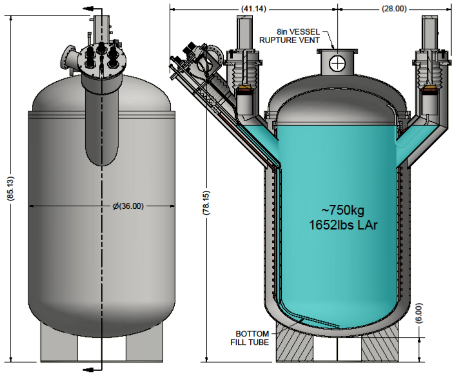
[2] To appear in M. R. Heath, IU Thesis

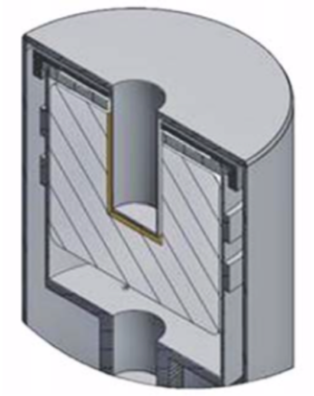


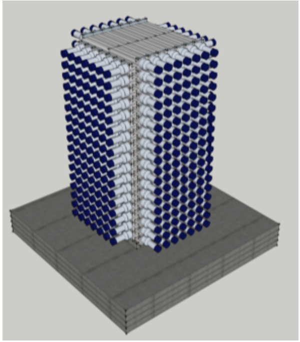
- Results from more CsI running, improved analysis
- Results from 22-kg LAr detector
- Treatment of shape systematics

COHERENT **CEvNS** Detector Status and **Farther Future**

Nuclear Target	Technology	Mass (kg)	Distance from source (m)	Recoil threshold (keVr)	Data-taking start date	Future
CsI[Na]	Scintillating crystal	14.6	20	6.5	9/2015	Finishing data-taking
Ge	HPGe PPC	16	22	<few	2019	
LAr	Single-phase	22	29	20	12/2016, upgraded summer 2017	Expansion to **750 kg scale**
NaI[Tl]	Scintillating crystal	185*/ 3388	28	13	*high-threshold deployment summer 2016	Expansion to **3.3 tonne**, up to 9 tonnes







+ concepts for other targets

Reducing systematic uncertainties

2017 CsI measurement

Uncertainties on signal and background predictions	
Event selection	5%
Quenching factor	25%
Flux	10%
Form factor	5%
Total uncertainty on signal	**28%**
Beam-on neutron background	25%

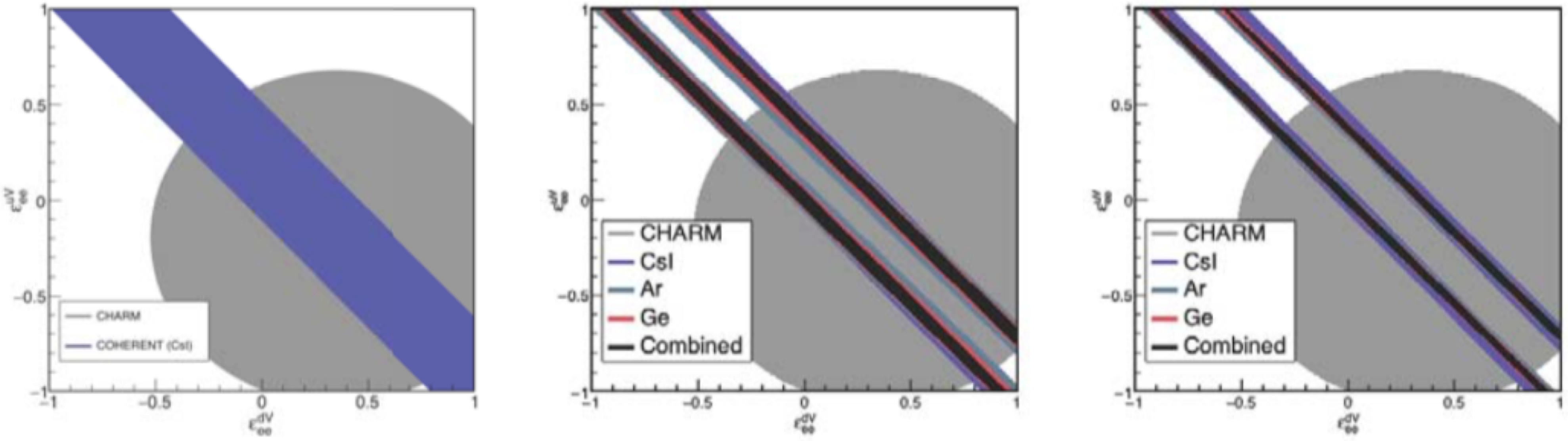
Dominant uncertainty (detector-dependent)

Next largest uncertainty (affects all detectors)

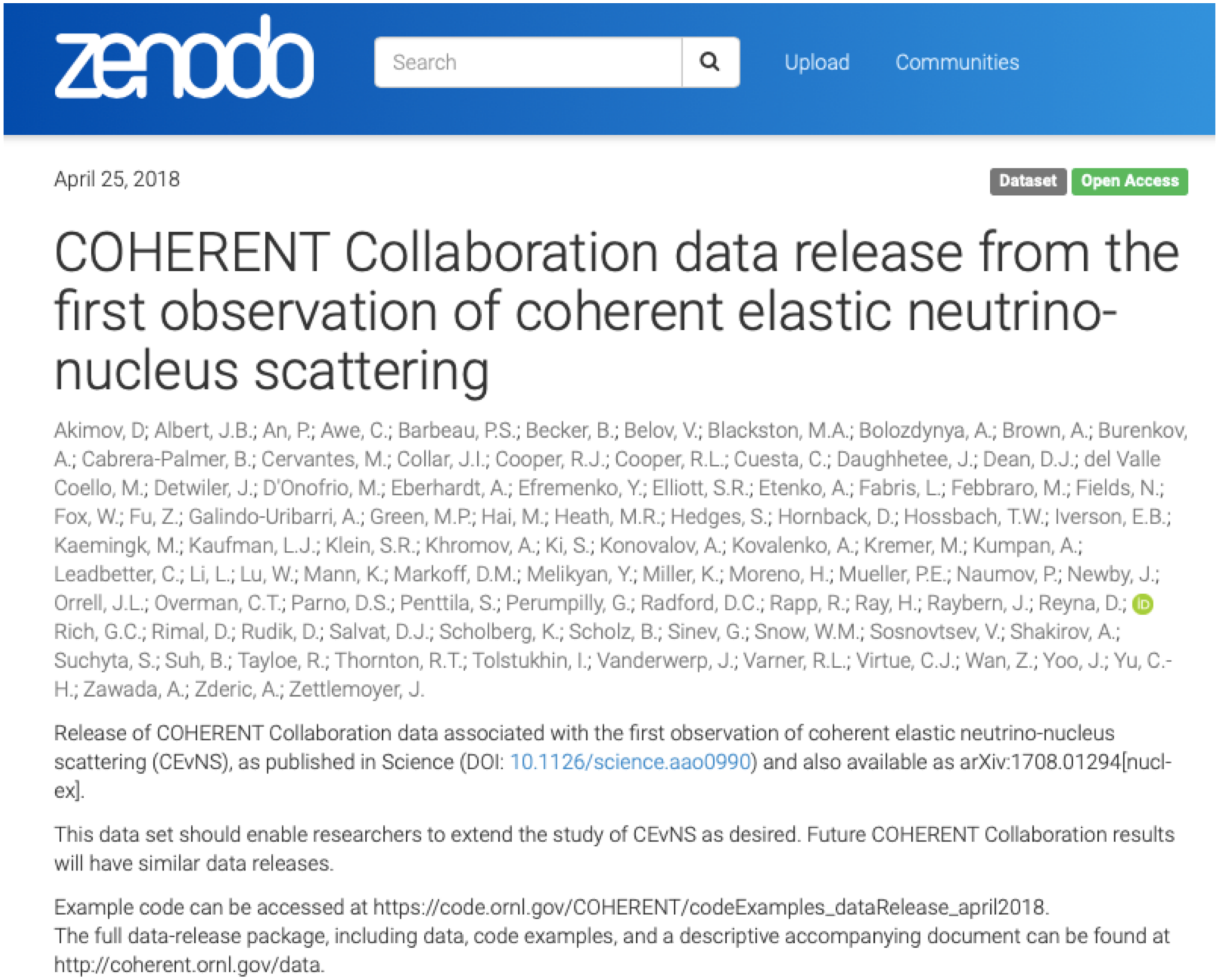
- ancillary quenching factor measurements are important for the physics program
- D_2O for flux normalization also planned

  (ν_e-d interaction has few % theoretical uncertainty)

Estimated future sensitivities for NSI



Combination
of targets
improves
sensitivity



April 25, 2018

COHERENT Collaboration data release from the first observation of coherent elastic neutrino-nucleus scattering

Akimov, D; Albert, J.B.; An, P.; Awe, C.; Barbeau, P.S.; Becker, B.; Belov, V.; Blackston, M.A.; Bolozdynya, A.; Brown, A.; Burenkov, A.; Cabrera-Palmer, B.; Cervantes, M.; Collar, J.I.; Cooper, R.J.; Cooper, R.L.; Cuesta, C.; Daughhetee, J.; Dean, D.J.; del Valle Coello, M.; Detwiler, J.; D'Onofrio, M.; Eberhardt, A.; Efremenko, Y.; Elliott, S.R.; Etenko, A.; Fabris, L.; Febbraro, M.; Fields, N.; Fox, W.; Fu, Z.; Galindo-Uribarri, A.; Green, M.P.; Hai, M.; Heath, M.R.; Hedges, S.; Hornback, D.; Hossbach, T.W.; Iverson, E.B.; Kaemingk, M.; Kaufman, L.J.; Klein, S.R.; Khromov, A.; Ki, S.; Konovalov, A.; Kovalenko, A.; Kremer, M.; Kumpan, A.; Leadbetter, C.; Li, L.; Lu, W.; Mann, K.; Markoff, D.M.; Melikyan, Y.; Miller, K.; Moreno, H.; Mueller, P.E.; Naumov, P.; Newby, J.; Orrell, J.L.; Overman, C.T.; Parno, D.S.; Penttila, S.; Perumpilly, G.; Radford, D.C.; Rapp, R.; Ray, H.; Raybern, J.; Reyna, D.; Rich, G.C.; Rimal, D.; Rudik, D.; Salvat, D.J.; Scholberg, K.; Scholz, B.; Sinev, G.; Snow, W.M.; Sosnovtsev, V.; Shakirov, A.; Suchyta, S.; Suh, B.; Tayloe, R.; Thornton, R.T.; Tolstukhin, I.; Vanderwerp, J.; Varner, R.L.; Virtue, C.J.; Wan, Z.; Yoo, J.; Yu, C.-H.; Zawada, A.; Zderic, A.; Zettlemoyer, J.

Release of COHERENT Collaboration data associated with the first observation of coherent elastic neutrino-nucleus scattering (CEvNS), as published in Science (DOI: 10.1126/science.aao0990) and also available as arXiv:1708.01294[nucl-ex].

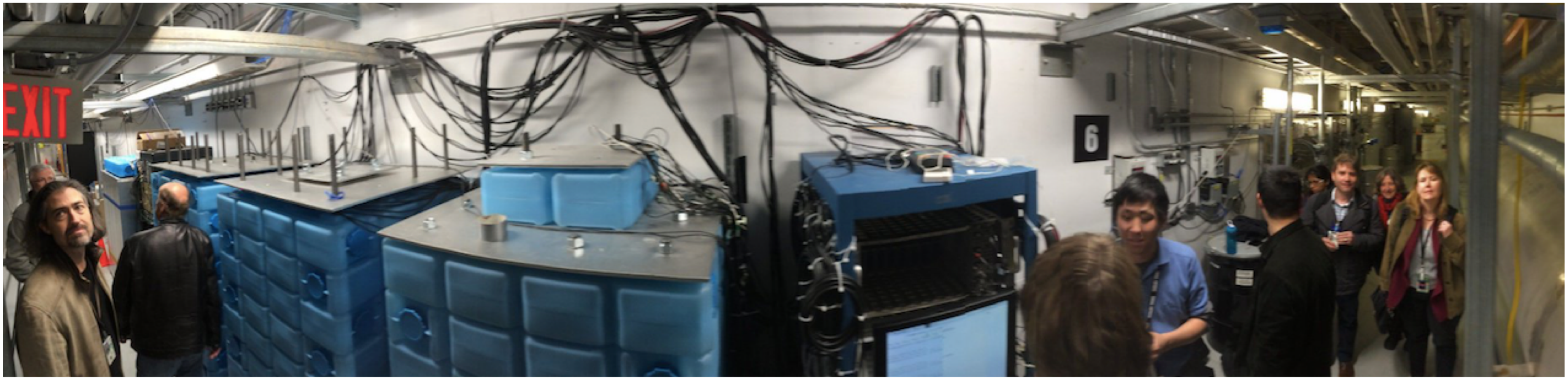
This data set should enable researchers to extend the study of CEvNS as desired. Future COHERENT Collaboration results will have similar data releases.

Example code can be accessed at https://code.ornl.gov/COHERENT/codeExamples_dataRelease_april2018.
The full data-release package, including data, code examples, and a descriptive accompanying document can be found at http://coherent.ornl.gov/data.

Available for phenomenologists

Summary

- **CEvNS:**
  - large cross section, but tiny recoils, α N^2
  - accessible w/low-energy threshold detectors, plus extra oomph of stopped-pion neutrino source
- **First measurement** by COHERENT CsI[Na] at the SNS
- **Meaningful bounds on beyond-the-SM physics**



- **It’s just the beginning....** LAr + more CsI soon
- Multiple targets, upgrades and new ideas in the works!
- Other CEvNS experiments at reactors are joining the fun

  (CAPTAIN Mills, TEXONO, CONUS, CONNIE, MINER, RED, Ricochet, Nu-cleus...)